

Are too many head CT scans ordered in emergency departments?

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Abstract

Objectives: The aims of this study were to: (i) characterize ordering of head computed tomography scans from the emergency department; (ii) determine the proportion of scans that yield an abnormal result; (iii) correlate results with clinical syndromes and neurological findings; and (iv) identify areas where a change in ordering practice may be warranted.

Method: Prospective case identification with detailed explicit review of clinical notes and radiological findings.

Results: Two hundred and thirty-six cases were analysed. The rate of head computed tomography scans was 2.3% of all emergency department attendances. Of the scans, 21.6% were abnormal with the most common abnormalities being haemorrhage or infarction. Indications that correlated highly with abnormal scans were altered mental state (43.7%), focal weakness (36.7%), mild head injury (21.2%) and confusion (18.5%). Headache, transient ischaemic attack and seizure had low correlations with abnormal scans.

Conclusion: The results of this study suggest that the overall rate of head computed tomography scans ordered by the study emergency department was appropriate. It also supports the development of guidelines for the ordering of head computed tomography scans in patients with headache, seizure and transient ischaemic attack.

Key words: *computed tomography (head), head injury, test utilization.*

Introduction

Computerized tomography imaging (CT) of the head has resulted in a dramatic improvement in the ability to identify intracranial pathology. Head CT is highly reliable, non-invasive, painless, quick and available on an urgent, 24 h-a-day basis at most hospitals. Thus it is very attractive to emergency physicians for use in the identification (and exclusion) of significant intracranial

pathology. Concern has been raised, however, about the cost implications of widespread use of CT and the impact of high emergency department (ED) use of access to CT imaging for other patients.

This project originated from concerns expressed by the Radiology Department and Hospital Executive at Western Hospital about a perceived over-utilization of head CT by the ED. The aims of this study were to: (i) characterize ordering of head CT from the ED;

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(ii) determine the proportion of scans that yield an abnormal result; (iii) correlate results with clinical syndromes and neurological findings; and (iv) identify areas where a change in ordering practice may be warranted.

Methods

This study was conducted as a prospective case series between 22 April and 21 June 1999 at Western

Table 1. Cranial computed tomography finding based on primary complaint

Primary complaint	Total <i>n</i> (%)	Normal <i>n</i> (%)	Abnormal <i>n</i> (%)
Focal weakness	49 (20.8)	31 (63.3)	18 (36.7)
Headache	48 (20.3)	43 (89.6)	5 (10.4)
Minor head injury	33 (14)	26 (78.8)	7 (21.2)
Confusion	27 (11.4)	22 (81.5)	5 (18.5)
Collapse	24 (10.2)	20 (83.3)	4 (16.7)
Seizure	22 (9.3)	20 (90.9)	2 (9.1)
Altered mental status	16 (6.8)	9 (56.3)	7 (43.7)
Vertigo	7 (3)	6 (85.7)	1 (14.3)
Ataxia	4 (1.7)	3 (75)	1 (25)
Dizziness	4 (1.7)	4 (100)	–
Dysphasia	1 (0.4)	–	1 (100)
Dysarthria	1 (0.4)	1 (100)	–

Table 2. Discharge diagnosis correlated with scan result

Discharge diagnosis	Normal <i>n</i> (%)	Abnormal <i>n</i> (%)	Total no.
CVA	19 (34.5)	36 (65.5)	55
MHI	24 (85.7)	4 (14.3)	28
Seizure	20 (95.2)	1 (4.8)	21
TIA	19 (95)	1 (5)	20
Migraine	14 (100)	–	14
Headache	13 (100)	–	13
Acute brain syndrome	9 (100)	–	9
Intoxication	5 (100)	–	5
Meningitis	5 (100)	–	5
Labyrinthitis	5 (100)	–	5
Collapse	4 (100)	–	4
Neoplasm	1 (25)	3 (75)	4
Overdose	3 (75)	1 (25)	4
Other	44 (89.8)	5 (10.2)	49
Total	185	51	236

CVA, cerebrovascular accident; MHI, minor head injury; TIA, transient ischaemic attack.

Hospital, a 300-bed university teaching hospital. The ED has an annual census of approximately 36 000 patients, more than 98% of whom are adults.

All patients who underwent cranial CT scan were identified from radiology department records. The clinical record of each patient was explicitly reviewed by the research assistant and the following data collected: principal complaint necessitating the scan, clinical features (in particular the presence of neurological signs), disposition from the ED and final diagnosis. 'Principal complaint necessitating the scan' was identified from ED case records as the complaint referred to in the decision to order the scan or the major presenting complaint. This process identified 12 principal complaint categories: focal weakness, headache, mild head injury, confusion, collapse, seizure, altered mental state, vertigo, ataxia, dysphasia and dysarthria. Clinical features were determined from the case notes. If a feature was not documented, it was presumed to be absent. The result of the scan was obtained from radiology department computerized records.

A normal scan was defined as one that was reported as normal or demonstrated pre-existing changes or atrophy alone. An abnormal scan was defined as one that demonstrated pathology not previously identified.

Data were analysed using a Microsoft Access database program.

Table 3. Clinical variables correlated with scan results

Clinical variable	Scan normal <i>n</i> (%)	Scan abnormal <i>n</i> (%)
Suspicion of fractured skull	3 (50)	3 (50)
Abnormal reflexes	19 (51.4)	18 (48.6)
Pupils unequal or non-reactive	14 (63.6)	8 (36.4)
Focal neurological signs	65 (63.7)	37 (36.3)
GCS score less than 15	50 (64.9)	27 (35.1)
Focal weakness	59 (68.6)	27 (31.4)
Collapse	24 (75)	8 (25)
Headache	66 (76.7)	20 (23.3)
Confusion	38 (77.6)	11 (22.4)
LOC	38 (77.6)	11 (22.4)
Consumption of alcohol	11 (78.6)	3 (21.4)
Amnesia	20 (83.3)	4 (16.7)
Ataxia	23 (88.5)	3 (11.5)
Seizure	21 (91.3)	2 (8.7)

GCS, Glasgow Coma Scale; LOC, loss of consciousness.

Results

The total number of head CT scans in the study period was 239 and 236 patient histories were available for review (98.7%). During the same period there were 10 364 attendances at the emergency department, thus, the rate of head CT was 2.3% of all ED attendances.

The age of patients in the study ranged from 15 to 92 years with an average of 56 years.

Of the 236 scans included in the study, 51 (21.6%) were classified as abnormal and 185 (78.4%) as normal. The abnormal findings were for haemorrhage (8.9%), infarction (6.8%), neoplasm (1.7%) and other (4.2%) (Fig. 1). The 'other' group includes cerebral abscess ($n = 1$), contusion ($n = 3$), cyst ($n = 1$), haematoma ($n = 1$), mild hydrocephalus ($n = 1$) and ischaemia ($n = 2$).

The results of the CT scans in relation to the primary complaint are shown (Table 1). The most common indications cited for scans were focal weakness ($n = 49$), headache ($n = 48$) and minor head injury (MHI) ($n = 33$). The indication that correlated most highly with abnormal scans was altered mental state, for which 43.7% of scans (16) were abnormal. Other indications that correlated highly with abnormal scans were focal weakness (36.7%), mild head injury (21.2%) and confusion (18.5%). The indications that had a low yield for abnormal scans were for headache (10.4%), seizure (9.1%), vertigo (14.3%) and collapse (16.7%).

The final hospital discharge diagnosis for all patients who had a cranial CT is shown (Table 2). The categories listed are based on a minimum of four patients for each of those categories. As can be seen, the largest diagnostic group was cerebrovascular accident (CVA).

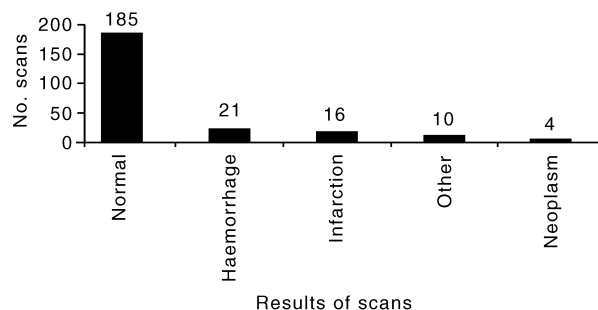


Figure 1. Results of head computed tomography scans.

Presence of clinical variables was correlated with the result of scans. The findings are summarized (Table 3). Higher yield criteria for abnormal scans were represented by suspicion of fractured skull (50%), abnormal reflexes (48.6%), pupils non-reactive or unequal (36.4%), Glasgow Coma Scale score less than 15 (35.1%), presence of focal neurological signs (36.3%) and focal weakness (31.4%).

Discussion

That abnormal scans were found in 21.6% of cases where a scan was ordered is a significant finding. It suggests that, overall, current ordering practices result in a high yield of positive scans. This rate of abnormal scans compares with that identified by Sinclair *et al.* of 25% abnormal scans for scans ordered by emergency physicians.¹ In contrast, Rothrock *et al.* found an abnormal scan rate of 8% and suggested that their criteria for ordering a CT scan was too liberal.²

The current clinical criteria for ordering a CT scan from the ED for the patients who present with focal weakness, confusion, MHI and altered mental status appear to be reasonable, with all these conditions yielding a high rate of abnormal scans. Clearly, not all patients with these clinical syndromes are scanned and reliance is placed on clinical assessment by ED staff. The high positive result rate is consistent with a high level of discrimination in the ED staff; it could also be interpreted as too few patients undergoing the test and, therefore, potential missed findings. The scope of the present study did not address the latter question.

Despite the overall high rate of positive scans for the study group, some areas of CT ordering had low

The first or worst headache of their life
Neurological symptoms
Altered conscious state
Age over 55 years
Headache of acute onset
Pain in the occipito-nuchal region
Co-existing seizure activity
Associated nausea and vomiting
Syncope
Neck stiffness

Figure 2. Literature-based indications for head computed tomography in patients with headache. Data from Ramirez-Lassepas *et al.*,³ BM Frishberg,⁴ and Field and Wang.⁵

positive yields. These scans may be considered excessive in the light of the findings and current evidence. Those indications for ordering CT scans that may be particularly questioned include the clinical presentation of headache, resolved transient ischaemic attack (TIA) and seizure. It must be remembered, however, that focusing on the rate of positive scans may undervalue the importance of a negative scan in clinical decision-making.

Within the literature, there is immense debate about the decision to scan or not to scan the patient with a headache. Some of the recommendations proposed in the literature are to perform a head CT on patients with headache who meet any of the criteria shown (Fig. 2). One of the key reasons for head CT in headache is to rule out a subarachnoid haemorrhage (SAH). Linn *et al.*⁶ and Schull⁷ warn that the patient with headache as the sole symptom has a risk of SAH of approximately 12%.

In Linn *et al.*'s retrospective study of patients complaining of sudden and severe headache, 103 patients of 148 had headache as the only symptom and 12 proved to have SAH.⁶ In the present study, five patients had SAH, of whom four had altered mental status and other suggestive symptoms on presentation.

Whether to scan the seizure patient is also controversial. It is current practice in the study ED not to perform an emergency head scan on a patient with a first-time seizure unless they have neurological signs, a history of cancer or fail to make a full and prompt recovery. Out-patient CT scan is employed as an alternative. Patients known to have epilepsy who present with a further seizure are not routinely scanned. Clinical judgement is employed in deciding whether a scan is indicated. In the present study, one of 21 scans performed for seizure was abnormal. This patient had neurological signs present on examination. Greenberg *et al.*⁸ developed clinical guidelines to direct the appropriateness and urgency of the CT scan for the seizure patient. These guidelines have not been validated by clinical practice and, therefore, reflect scientific and clinical information only. They recommend that the patient with a first-time seizure be scanned immediately to detect life-threatening lesions if there is a new focal deficit, persistent altered mental status, fever, recent trauma, persistent headache, history of cancer, history of anticoagulation or suspicion of AIDS. In addition, they recommend that, for first-time seizure patients, emergent scans should be considered if the patient is aged over 40 years or the seizure was partial in character. They recommend

emergent scanning should be performed for the patient with a past history of seizure where the pattern or type of seizure is atypical, where there is prolonged postictal confusion or worsening mental status. This is supported by Ramirez-Lassepas *et al.*⁹ who, using similar guidelines for deciding whether to scan patients with a first seizure, reported a CT abnormality rate of 37%.

That 95% of patients with an ED diagnosis of TIA had normal scans was interesting, but not surprising. The one abnormal scan demonstrated mild hydrocephalus only, the clinical significance of which is doubtful. The practice of scanning these patients reflects the preference of the neurology department at the study hospital for urgent CT scan and admission for all patients with TIA. It has been suggested that CT scan rarely alters treatment in patients with TIA.¹⁰ Rolak *et al.*¹⁰ studied 163 patients presenting with TIA, of whom 145 had CT scans performed. No CT altered patient treatment. They claim that other pathways of investigation, including clinical assessment and carotid Doppler studies, for these patients might be effective and cost-efficient. They support their algorithm by stating that '... extensive diagnostic testing as part of a routine screening evaluation for TIAs has a low yield and is not indicated in most patients when an adequate history and physical examination can be obtained'.

Sandercock has a more conservative view. He suggests that patients presenting with TIA should receive a scan if there is doubt concerning the diagnosis, a gradual onset of deficit, no clear history of sudden onset, no clear focal neurological signs or there is a need to exclude intracranial haemorrhage.¹¹

There are some limitations to this study. This study is descriptive and based on current practice. No attempt was made to systematically study patients with particular clinical syndromes. Although case identification occurred prospectively, some of the data were collected from clinical case notes, so documentation errors (in particular omissions) may have affected the results. Additionally, no attempt was made to determine whether abnormal scans impacted on clinical management. Also, this study was conducted at a single site with a fairly high ratio of senior to junior staff. The results may not be generalizable to other settings with different staff ratios and practice patterns. Despite these limitations, the authors believe that the data reported are a reasonable reflection of current practice.

Conclusion

The results of this study suggest that the overall rate of head CT scan ordering in the study ED is appropriate. It also supports the development of guidelines for the ordering of head CT scans in patients with headache, seizure and TIA.

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