Computerised tomography and acute traumatic head injury: time for change?

J Cranshaw, G Hughes, M Clancy

Abstract

The aim was to reconsider the “Guidelines for initial management of head injury in adults” — particularly with respect to the indications for computerised tomographic (CT) scanning — suggested by “a group of neurosurgeons” over a decade ago and still followed in some accident and emergency (A&E) departments. These recommendations are placed in the context of more recent research and the increased number of A&E departments with on-site rapid access to a CT scanner but without a resident neurosurgical facility. A case can be made for an updated policy with more liberal indications for CT scanning of acutely head injured adults in peripheral A&E departments. However, calculating the cost-efficiency of more frequent use of what is now a common but relatively expensive resource would remain a challenge.


Key terms: computerised tomography; accident and emergency; head injuries

In 1983, when the guidelines for initial management of head injury were discussed by radiologists and neurosurgeons under the auspices of the DHSS at Harrogate,1 computerised axial tomography (CT) scanners were predominantly located in neurological referral centres. The guidelines of 19842 (table 1) therefore “assume a situation where 24 hour scanning facilities are limited to the regional centre, so that access is available only to selected patients,” and only the triage tools of history, examination, and skull radiology are envisaged as available to peripheral accident and emergency (A&E) departments. With these indirect indicators of intracranial events, acutely head injured patients can be assigned to “high”, “intermediate”, and “low” risk groups3 with respect to the possible development of a surgically significant traumatic intracranial haematoma and management decisions taken on this basis. A revised risk assessment for these groups, together with their expected proportion of all A&E acute head injury attendees is presented in table 2.4

Argument and discussion

Figure 1 contains a decision diagram based on the 1984 guidelines. By following the different clinical characteristics of acutely head injured patients through the network, it can be seen that patients with externally apparent neurological problems or in coma [Glasgow coma score (GCS) 3–8] should be referred immediately for neurosurgical assessment and scanning. Later, patients with neurological symptoms or signs who have also been found to have

Table 1 Guidelines for initial management after head injury in adults

| For skull x-ray examination after recent head injury | 1 Loss of consciousness or amnesia at any time |
| 2 Neurological symptoms or signs | 3 Cerebrospinal fluid or blood from the nose or ear |
| 4 Suspected penetrating injury | 5 Scalp bruising or swelling |

For admission to a general hospital

1 Confusion or any other depression of the level of consciousness at the time of examination
2 Skull fracture
3 Neurological symptoms or signs
4 Difficulty in assessing the patient – for example, alcohol, epilepsy, or other medical condition
5 Lack of a responsible adult to supervise the patient; other social problems

Note – brief amnesia after trauma with full recovery is not sufficient indication for admission. Relatives or friends of patients sent home should receive written advice about changes that would require the patient to be returned urgently to hospital.

For consultation with a neurosurgeon

1 Fractured skull with any of the following: confusion or worse impairment of consciousness, one or more epileptic fits, or any other neurological symptoms or signs
2 Coma continuing after resuscitation – even if no skull fracture
3 Deterioration in level of consciousness
4 Confusion or other neurological disturbances persisting for more than eight hours, even if there is no skull fracture
5 Depressed fracture of the skull vault
6 Suspected fracture of the base of skull (cerebrospinal fluid rhinorrhoea or otorrhoea, bilateral orbital haematomata, mastoid haematoma, or evidence of penetrating type of injury such as spike or gunshot)

Table 2 Type of head injury, risk of surgically significant traumatic intracranial haematoma (TIH) and expected proportions of A&E attendees with head injuries and surgically treated TIH (after ?)

<table>
<thead>
<tr>
<th>Risk of surgically significant TIH</th>
<th>Absolute risk of surgically significant TIH in adults</th>
<th>Percent of A&amp;E attendees with head injuries</th>
<th>Percent of surgically treated TIH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High risk</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Coma (GCS ≤8)</td>
<td>1 in 8</td>
<td>1%</td>
<td>47%</td>
</tr>
<tr>
<td>Skull fracture with neurological symptoms or signs</td>
<td>1 in 5</td>
<td>0-4%</td>
<td>29%</td>
</tr>
<tr>
<td><strong>Intermediate risk</strong></td>
<td></td>
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<tr>
<td>Skull fracture and GCS 15</td>
<td>1 in 45</td>
<td>1-3%</td>
<td>10%</td>
</tr>
<tr>
<td>GCS 9–14</td>
<td>1 in 180</td>
<td>5-4%</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Low risk</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully conscious without skull fracture</td>
<td>1 in 7866</td>
<td>91-9%</td>
<td>3%</td>
</tr>
<tr>
<td>GCS, Glasgow coma score</td>
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</tbody>
</table>

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CT and acute traumatic head injury

Figure 1  A decision diagram based on the 1984 guidelines for initial management of head injury in adults.1

- a skull fracture will be referred. Later still, others can “earn” their referral either by failing to improve within 8 h or by deteriorating under observation in hospital or at home. In the text of the 1984 paper, the justification given for this particular prioritisation of peripheral hospital and neurosurgical centre resources is that “earlier investigation of patients at high risk of an intracranial complication will improve considerably the overall results”, and it is accepted that “without an increase in facilities for CT, it may not be feasible to scan urgently” those patients at intermediate risk. It is now appreciated that while patients in the intermediate risk group may constitute only 7% of all patients presenting with acute head injuries to A&E departments, this group contains up to one third of all surgically significant traumatic intracranial haematomas. The institution of the 1984 guidelines has improved morbidity and mortality for victims of acute head injuries. However, as peripheral hospital scanning capability has increased to a size where the urgent scanning of intermediate risk patients may be feasible, how should we aim to improve our practice further? The aim of head injury management is to prevent avoidable morbidity and mortality. Two principal observations from recent research in the field of head injury outcome are pertinent.

The first observation is that improved outcome for patients with traumatic intracranial haematoma has been shown to be related to earlier identification of the neurosurgical problem.5-7 The desire to promote this improvement was expressed at the end of the 1984 guidelines: “More patients need to go to a neurosurgical unit for computed tomography and to reach there sooner than many do at present.” If a traumatic intracranial haematoma is suspected, CT scanning should be an early investigation. An immediate benefit of early CT scanning should be a reduction in the practice of waiting and watching at-risk patients on peripheral hospital wards for physical signs that may occur late in the evolution of traumatic intracranial haematoma and secondary brain damage. In-hospital observation has been criticised as both inefficient and costly.12 13 If patient deterioration occurs, the outcome is likely to be better if it occurs in a neurological centre after early identification of the potential problem and timely transfer.

The second observation is that improved outcome for acutely head injured patients as a whole group may now fundamentally rely on extending indications for CT scanning to lower risk patients. Evidence that a “substantial minority” of clinically low risk patients with traumatic intracranial haematoma in the United Kingdom are poorly served by the 1984 guidelines, with resultant excessive morbidity and mortality, has been presented.8 9 Similarly, in North America, a comparison of head injury outcome between 41 hospitals suggested that “reduction in mortality for hospitalised patients is not likely to be due to spectacular
saving of high risk patients, but due to the prevention of deterioration in patients who initially appear to be at low risk", and further that "the patients at greatest risk of inadequate diagnosis and treatment are not those at high risk who might or might not be saved by highly specialised intensive care, but are those who are predicted to be at relatively low risk". In addition, it is likely that low risk patients in whom neurosurgically significant problems are diagnosed quickly and managed expertly may have better outcomes than those with high risk clinical characteristics who are at present automatically referred. Extending CT scanning to patients at lower risk of traumatic intracranial haematoma may be more cost-efficient than continuing to allocate resources in the bias justified in the 1984 guidelines, but how wide should we cast the scanning net?

Teasdale et al have suggested "the optimum approach would be for all patients with persisting impaired consciousness (defined as GCS 9–14) or coma to have CT". They have also advised extending "the indications for CT to include patients who have a skull fracture who are fully conscious". Based on data from Scottish A&E departments, this policy would entail an extra 1200 CT scans per million population per year but "should achieve the early detection of 99% of intracranial haematoma. A remediable haematoma would be disclosed in 3% of the patients investigated. In another 5–10%, CT would show an abnormality requiring expert neurological assessment". An 18 month survey in the Emilia-Romagna region of Italy where these recommendations were adopted for adult patients supported these predictions.16

One problem encountered by lowering the clinical threshold for CT scanning in this Italian study was that some patients presented neurosurgeons with difficult choices between surgical and conservative management. However, this was tolerated as being "far better than the ‘inadvertent conservative management’ of the past". Some concern has also been expressed about the possibility of obtaining a falsely reassuring normal result by so-called "ultra-early" or "zero time" CT scanning and an acutely head injured patient who then deteriorates because of the subsequent development of a traumatic intracranial haematoma.10 This problem has been especially experienced in patients with traumatic extradural haematoma. However, one study concluded that "one should not generalise or speculate that perhaps all extradural haematoma are delayed if CT is performed early in all cases of head injury".11 Delayed extradural haematoma is characterised by, among others, signs of significant primary brain injury and skull fracture. Therefore, regardless of the initial CT result, patients with these characteristics should be referred and carefully monitored in a neurosurgical centre. Whether early CT scanning might prejudice the risk of acute head injury can only be resolved when more data are available. At present such fears should not deter one from adopting early CT scanning, which has already been shown to improve overall outcome.

In the USA, imaging recommendations after acute head injury were made by a multidisciplinary review panel in 198717 (see table 3), but with variable clinical uptake.18–20 In recent years, the loose recommendation to "consider CT scanning" for patients at "moderate" risk of intracranial haemage has been applied to the extent that all such head injuries are now imaged in some centres. A further inclination, if not indication, to perform a CT scan is the American medicolegal climate that has "zero tolerance" for the albeit remote possibility of a patient considered at "moderate" risk of intracranial injury ultimately becoming neurologically devastated or dying without receiving the benefit of an early CT scan. However, although a great deal of retrospective American data and comment have been published about the percentage of "abnormal" CT scans in various acutely head injured populations and related patient characteristics,21–22 the criteria for CT scanning the patients studied are rarely explicit23–24 and not all relevant patients in

<table>
<thead>
<tr>
<th>Low risk group, possible findings</th>
<th>Moderate risk group, possible findings</th>
<th>High risk group, possible findings</th>
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</thead>
<tbody>
<tr>
<td>● Asymptomatic</td>
<td>● History of change of consciousness at the time of injury or subsequently</td>
<td>● Depressed level of consciousness not clearly due to alcohol, drugs, or other cause (eg, metabolic and seizure disorders)</td>
</tr>
<tr>
<td>● Headache</td>
<td>● History of progressive headache</td>
<td>● Focal neurological signs</td>
</tr>
<tr>
<td>● Dizziness</td>
<td>● Unreliable or inadequate history of injury</td>
<td>● Decreasing level of consciousness</td>
</tr>
<tr>
<td>● Scalp laceration</td>
<td>● Age less than 2 years (unless injury very trivial)</td>
<td>● Penetrating skull injury or palpable depressed fracture</td>
</tr>
<tr>
<td>● Scalp contusion or abrasion</td>
<td>● Post-traumatic seizure</td>
<td></td>
</tr>
<tr>
<td>● Absence of moderate risk or high risk criteria</td>
<td>● Vomiting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Post-traumatic amnesia</td>
<td></td>
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<tr>
<td></td>
<td>● Multiple trauma</td>
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<tr>
<td></td>
<td>● Serious facial injury</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Signs of basilar fracture</td>
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<tr>
<td></td>
<td>● Possible skull penetration or depressed fracture</td>
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<tr>
<td></td>
<td>● Suspected physical child abuse</td>
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</tbody>
</table>

**Recommendations**

- Observations alone: discharge patients with head injury information sheet (listing subdural precautions) and a second person to observe them.
- **Recommendations**
  - Extended close observation (watch for signs of high risk group)
  - Consider CT examination and neurosurgical consultation
  - Skull series may rarely be helpful if positive, but does not exclude intracranial injury if normal.

CT, computerised tomography.
of acute head injured patients. Our recommendations are based on recent prospective studies and include a history of loss of consciousness (up to 60 minutes), a Glasgow Coma Score (GCS) of 13-15, and severe amnesia. Neurological deficits, such as a focal neurological sign, a neck stiffness, or a loss of consciousness, should be considered in patients who have been injured. Most patients with a history of loss of consciousness (up to 60 minutes), a GCS of 13-15, and severe amnesia are likely to have been injured. These recommendations are supported by a retrospective study, which found that patients who had a history of loss of consciousness (up to 60 minutes), a GCS of 13-15, and severe amnesia were more likely to have a favorable outcome. However, these recommendations are not based on clinical data and should be used as a guideline for the management of acute head injured patients.
neurological examination and CT scan. Patients in the prospective study were allowed to sober up if necessary, were re-examined before discharge, and were allowed home regardless of whether there was someone at home to observe them. By American criteria, admission was avoided in more than 80% of patients and these were apparently discharged safely within 3–12 hours.

In practice it is unlikely that a patient with GCS less than 15 or neurological signs or symptoms could be discharged from an A&E department. However, the question of whether CT scanning acute head injuries, as a less expensive option, could or should be used to reduce the number of admissions is raised by these observations. Specifically, it could be asked, at what confidence level and cost-efficiency could neurologically normal patients with GCS 15 and intracranially normal CT scans be discharged whose “social condition, or lack of responsible adult or relative”, or whose assessment was difficult due to “alcohol, epilepsy or other medical condition” or whose skull fracture would normally mandate admission by the 1984 guidelines? This group of individuals routinely occupies a not insignificant bed space of whichever specialty over treats head injuries, particularly in inner city hospitals. For regular attenders of A&E departments with acute head injuries the risks of repetitive exposure to x irradiation by CT might have to be taken into consideration, as might the possible risks of general anaesthesia required to obtain some scans. More large studies are required.

One important standard laid down in the 1984 guidelines remains. Any change in CT scanning policy for acutely head injured patients in peripheral A&E departments should be by agreement with radiologists and the local neurosurgical referral centre. When new criteria are decided then “a consensus about what management is locally appropriate could appreciably improve the overall care of head injuries in a region. But this would only happen if the agreed policy became widely known, especially among junior staff – who are everywhere the most directly concerned with these patients”.

21 Reimus W, Wippold F, Erickson K. Practical selection criteria for noncontrast cranial computed tomography in
27. Stein S. J Trauma 1993:35:491 [correspondence].

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