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Patients who reattend after head injury: a high risk group

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Abstract

Objective—To assess risk factors for important neurosurgical effects in patients who reattend after head injury.

Design—Retrospective study.

Subjects—606 patients who reattended a trauma unit after minor head injury.

Main outcome measures—Intracranial abnormality detected on computed tomography or the need for neurosurgical intervention.

Results—Five patients died: two from unrelated causes and three from raised intracranial pressure. On multiple regression analysis the only significant predictor for both abnormality on computed tomography (14.4% of reattenders) and the need for operation (5% of reattenders) was vault fracture seen on the skull radiograph ($P < 10^{-6}$); predictors for abnormal computed tomogram were a Glasgow coma scale score < 15 at either first or second attendance ($P < 0.0001$) and convulsion at second attendance ($P < 0.05$); predictive for operation only was penetrating injury of the skull ($P < 10^{-6}$). On contingency table analysis these associations were confirmed. In addition significant associations with both abnormality on computed tomography and operation were focal neurological abnormality, weakness, or speech disturbance. Amnesia or loss of consciousness at the time of initial injury, personality change, and seizures were significantly associated only with abnormality on computed tomography. Headache, dizziness, nausea, and vomiting were common in reattenders but were found to have no independent significance.

Conclusions—All patients who reattend after head injury should undergo computed tomography as at least 14% of scans can be expected to yield positive results. Where this facility is not available patients

with predictors for operation should be urgently referred for neurosurgical opinion. Other patients can be readmitted and need referral only if symptoms persist despite symptomatic treatment or there is neurological deterioration while under observation. These patients are a high risk group and should be treated seriously.

Introduction

The post-concussion syndrome of headache, dizziness, and various other non-specific symptoms is common after head injury and has been estimated to persist for at least two months in up to 57% of patients.¹ Less common, but of greater concern to most doctors in emergency facilities, is the occurrence of a delayed extradural haematoma or subdural haematoma. In our unit, as in many others, patients sent home after a head injury are always provided with an advice sheet on head injury instructing them to return should they develop symptoms suggestive of intracranial problems, such as severe headache, vomiting, convulsions, weakness, or abnormal drowsiness. Common sense suggests that patients who reattend are probably a high risk group, as symptoms are clearly not abating as expected with the passage of time. There has been little published on whether this is indeed so.

We examined retrospectively our experience of patients with head injury who return to hospital to establish the incidence of neurosurgically important lesions associated with various clinical features.

Patients and methods

Details of patients attending the trauma unit at Groote Schuur Hospital in Cape Town are recorded in the trauma unit register. All patients are over the age of

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TABLE I—Mechanism of injury in 606 patients who reattended a trauma unit after head injury

Mechanism	No (%)
Blunt assault	242 (39.8)
Occupant in motor vehicle crash	101 (16.7)
Stab wound	87 (14.4)
Fall	78 (12.9)
Pedestrian in motor vehicle crash	47 (7.8)
Blunt and sharp assault	11 (1.8)
Sport	3 (0.5)
Motor cycle accident	3 (0.5)
Other	34 (5.6)

13 years, as younger children are treated at a separate hospital. Registers were available for the period between 1 January 1988 and 31 May 1993. Over this period 140 344 patients were seen in the unit, 28 364 (20.2%) of whom had head injuries and 11 700 (41.3%) of whom underwent skull radiography. Skull radiographs were obtained if the history included loss of consciousness or amnesia and examination revealed confusion, inebriation, a scalp wound or large haematoma resulting from blunt injury, non-superficial penetrating scalp wound, or clinical signs of base of skull fracture. Computed tomography was requested at the initial attendance if the consciousness deteriorated or failed to improve under observation, compound depressive skull fracture was clinically suspected after blunt or penetrating injury, or focal signs were present. Patients were admitted for observation at the first attendance if they had subjective symptoms such as headache, dizziness, history of loss of consciousness or amnesia; objective evidence of severe head injury requiring skull x ray investigation or computed tomography as above; or no responsible carer was available to observe the patient at home.

A manual search of the registers yielded 634 patients

TABLE II—Delay to reattendance after head injury

Delay*	No who reattended in interval (% of total patients)	No with intracranial abnormalities on computed tomography (% of total reattending in interval)	No who required neurosurgical operation (% of total reattending in interval)
<24 Hours	17 (2.8)	0 (0.0)	0 (0.0)
1-3 Days	290 (47.9)	39 (13.5)	14 (4.8)
4-14 Days	248 (40.9)	41 (16.5)	12 (4.8)
>14 Days	51 (8.4)	7 (13.7)	4 (7.8)
Mean (SD) delay (days)	6.1 (9.0)	6.0 (7.7)	9.1 (15.6)

*Interval differences not significant at $P=0.05$.

TABLE III—Clinical features in 606 patients who reattended after head injury

Feature	No with positive variable (% of total patients)	No with intracranial abnormalities on computed tomography (% of total with this variable)	No who required neurosurgical operation (% of total with variable)
All patients	606 (100.0)	87 (14.4)	30 (5.0)
Features on first admission:			
Blunt trauma	508 (83.8)	67 (13.4)	14 (2.8)
Penetrating trauma	87 (14.4)	15 (17.2)	15 (17.2)*
Blunt and penetrating trauma	11 (1.8)	4 (36.4)	1 (9.1)
Amnesia/loss of consciousness	238 (39.3)	45 (18.9)	14 (5.9)
Glasgow coma scale score <15	82 (13.5)	24 (29.3)*	4 (4.8)
Base of skull fracture	38 (6.3)	9 (23.7)	2 (5.3)
Vault fracture on first x ray examination	97 (16.0)	33 (34.0)	16 (16.5)*
Features on second admission:			
Headache	454 (74.9)	57 (12.6)	20 (4.4)
Dizziness	160 (26.4)	15 (9.5)	5 (3.2)
Nausea/vomiting	161 (26.6)	17 (10.6)	9 (5.6)
Convulsions/fits	44 (7.3)	13 (29.5)*	17 (38.6)
Glasgow coma scale score <15 or drowsiness	44 (7.3)	35 (79.5)*	4 (10.0)
Personality change	13 (2.1)	6 (46.2)	1 (7.7)
Weakness	43 (7.1)	12 (27.9)	6 (14.0)
Focal neurological abnormality	16 (2.6)	9 (56.3)	4 (25.0)
Speech disturbance	6 (1.0)	4 (66.7)	2 (33.3)

*Significant variable on logistic regression ($P<0.05$) for this outcome.

TABLE IV—Findings on computed tomography in patients who reattended after head injury

Detail	No (%) of patients
Not scanned	283 (47.7)
Scanned:	323 (53.3)
Normal results*:	236 (73.1)
Abnormal results*:	87 (26.9)
Cerebral oedema	13 (14.9)
Cerebral contusion	48 (55.1)
Subarachnoid haemorrhage	2 (2.3)
Extradural haematoma	15 (17.2)
Subdural haematoma	13 (14.9)
Intracerebral haematoma	4 (4.6)
Abscess	5 (5.8)

*Skull fractures, intracranial air, and old pathology not included.

(2.2% of all head injuries) who had reattended with neurological complaints after initial non-operative management for head injury. After we excluded 28 patients whose records were incomplete or missing 606 patients remained in the study. All reattenders included were walking and talking on initial discharge from the unit either to home or to a convalescent facility. Most reattenders (361 (59.6%)) had been sent home on the same day whereas the rest had been admitted for a variable period (one to eight days) of observation on the ward. The patient records were examined for the mechanism of injury, a history of loss of consciousness, neurological findings at initial presentation, and the presence of skull fracture on the radiograph, if done, at the first attendance. At reattendance the symptoms, neurological findings, findings on computed tomography when appropriate, and outcome were noted. Patients not requiring computed tomography at reattendance were assumed to have unimportant findings for purposes of analysis if they proceeded to discharge without event after reattendance.

A stepwise reverse logistic regression analysis was then applied² with the various clinical features found at the first and second attendances as independent variables and intracranial abnormality on computed tomography or need for operative intervention as the dependent variables. Factors were kept in the model if significant at the 5% level. Odds ratios (95% confidence intervals) were calculated for single variables associated with raised incidence of abnormality by using the Epistat statistical program.³

Results

The 606 patients identified in this study represent 2.1% of the total number of patients treated for head injury over this time period. Two thirds of the patients were men, and the mean age was 28.1 years. Table I summarises the mechanism of injury, blunt assault and motor vehicle accidents being the most common. A vault fracture was visible in 97 of the 539 patients (18.0%) who had had skull radiography, and computed tomography had been performed on 77 patients (12.7%) at the initial attendance. This yielded abnormal results in 48 patients: vault fracture in 25, contusion in 22, base of skull fracture or intracranial air in 12, a small intracranial haematoma in seven, oedema in three, and unrelated findings in six.

Table II shows the time to reattendance. Nearly half of all patients came back four or more days after the injury. No patient who reattended on the same day required surgery. Table III summarises the clinical features on reattendance and associated incidence of abnormality on intracranial computed tomography (oedema, contusion, subarachnoid haemorrhage, or haematoma) and neurosurgical operation. None of the 20 patients who underwent computed tomography for a second time showed measurable change from the findings at the first attendance.

Of the 97 patients with vault fracture of the skull detected on radiography, 33 (34.0%) had abnormality on intracranial computed tomography as defined above, and 16 (16.5%) required neurosurgical intervention. No significant difference in the incidence of abnormality on computed tomography or operation was associated with presence or absence of skull radiography at the first attendance despite the policy to obtain these radiographs on the more severely injured patients.

At reattendance computed tomography was performed on 323 patients (53.3%) if indicated by the above mentioned criteria. It revealed an intracranial abnormality in 87 (14.4% of reattenders, 27% of those scanned); table IV gives the details. Thirty patients

Key messages

- Patients who reattend after being sent home after an apparently minor head injury are a high risk group
- Ideally all such reattenders should be investigated with early computed tomography
- When computed tomography is not possible select those at particular risk for urgent neurosurgical referral. Useful indicators are fracture on the skull radiography, penetrating head injury, objective signs such as focal neurological abnormality, and a reduced score on the Glasgow coma scale
- In hospitals without 24 hour access to computed tomography it is probably justified to give symptomatic treatment and observe those who have only subjective features such as headache or dizziness after head injury
- If the symptoms worsen at any time, or are not greatly improved by 12 hours after admission, or objective signs appear the patient should be referred for urgent computed tomography and a neurosurgical opinion

TABLE V—Neurosurgical operations in 606 patients who reattended after head injury

Operation	No of patients
Extradural haematoma	8
Subdural haematoma	6
Intracerebral haematoma	1
Intracranial abscess	5
Elevation of depressed fracture	7
Other*	3
Total	30

*The "other" operations were anterior fossa repair for leak of cerebrospinal fluid (one), mastoidectomy for sepsis (one), and osteitis of skull debridement (one).

(5% of reattenders) required operative intervention to evacuate a haematoma or an abscess or elevate a depressed skull fracture. Table V gives the indications for operation in these patients.

Table VI gives the calculated odds ratios for the risk of an intracranial abnormality on computed tomography and table VII the associated risk of requiring a neurosurgical operation, both related to positive single features on initial attendance or on return.

Septic complications occurred in 54 patients: 44 had wound sepsis, two had meningitis, five had a cerebral abscess, two had purulent otitis following blunt trauma, and one had osteitis of the skull.

Five patients died. Two died from pathologies not directly related to their head injuries: one had a gastric rupture and diagnosis had been delayed as attention had focused on the head injury; the second was readmitted with a left hemiparesis from an occlusion of the middle cerebral artery, but no embolic source or proximal carotid pathology could be found at necropsy. Three patients died from raised intracranial pressure: one from a chronic subdural haematoma and the second from a large posterior fossa subarachnoid haemorrhage. Both had been diagnosed correctly before death but response to neurosurgery was dis-

TABLE VI—Features significantly associated with intracranial abnormality on computed tomography

Feature	Odds ratio (95% confidence interval)	P value
First admission:		
Vault fracture on first x ray examination	4.3 (2.5 to 7.4)	< 0.000001
Glasgow coma scale < 15	3.0 (1.2 to 5.4)	0.00007
Amnesia/loss of consciousness	1.8 (1.1 to 2.9)	0.01
Second admission:		
Glasgow coma scale < 15	4.1 (2.4 to 6.9)	< 0.000001
Focal neurological abnormality	8.4 (2.8 to 26.0)	0.000008
Speech disturbance	12.5 (1.9 to 61.8)	0.002
Personality change	5.4 (1.6 to 18.5)	0.004
Convulsions/fits	2.8 (1.3 to 5.8)	0.006
Weakness	2.5 (1.2 to 5.4)	0.02

TABLE VII—Features significantly associated with neurosurgical operation

Feature	Odds ratio (95% confidence interval)	P value
First admission:		
Penetrating trauma	7.4 (3.2 to 16.9)	< 0.000001
Vault fracture on first x ray examination	7.0 (3.1 to 15.8)	< 0.000001
Second admission:		
Glasgow coma scale < 15	7.0 (3.1 to 15.8)	< 0.000001
Focal neurological abnormality	7.2 (1.8 to 26.6)	0.006
Weakness	3.6 (1.3 to 10.1)	0.01
Speech disturbance	10.2 (1.4 to 69.0)	0.03

appointing. A third patient convulsed and died soon after readmission; necropsy showed the patient had a pressure cone because of cerebral oedema and a large subarachnoid haemorrhage.

Discussion

The preventable morbidity resulting from intracranial haematoma remains a central concern of those concerned in the primary treatment of head injuries. There has been some recent controversy over the management of minor head injuries, with some recommending that computed tomography or skull radiography be limited to high risk patients⁴ and others a more liberal use of early computed tomography.^{5,6} There has also been discussion as to the cost effectiveness of hospital admission for observation⁷ or routine scanning,⁸ given the low incidence of abnormalities detected that require operative intervention.⁹

Whichever strategy is used the patient is always advised to return to hospital should neurological symptoms develop. There seems to be no literature, however, dealing with the management of this group of patients when they return to hospital.

In an ideal world all those reattending after head injury should undergo immediate computed tomography. This is clearly not practical, however, for the vast numbers of hospitals worldwide that still do not have a scanner facility on site and where it is therefore most important to identify with simple parameters patients who require urgent neurosurgical referral.

If the need for neurosurgical intervention is to be the criterion for transfer to a major facility, rather than abnormality results of a scan per se, then our data suggest that objective evidence of severe head trauma or intracranial haematoma such as vault fracture, decreased consciousness, or focal abnormality carries far more weight than subjective symptoms such as headache, vomiting, or dizziness. This is in agreement with the recommendations of Masters *et al.*⁴ Fits were predictive of abnormality on computed tomography in our patients (usually cerebral contusion) but not predictive of the need for operation.

Our data support the continued use of selective skull radiography to identify those at high risk for intracranial complications, particularly where computed tomography is not available. A skull fracture was present in over half of the patients who required operation and was found to be an indicator of high risk independent of other factors. It must be emphasised, however, that absence of a skull fracture does not exclude serious intracranial pathology, and objective clinical findings or persistent symptoms are also important in identifying high risk cases.

A high proportion of cranial stabs required operation, and one half of all patients requiring operation had sustained a penetrating head injury. It seems that liberal use of computed tomography is justified in this group. We acknowledge that cranial stabs are rare outside South Africa. These wounds, however, do occur in all countries from time to time, and our experience in this study may assist those who see fewer of these injuries.

We conclude that it remains difficult to predict which patients returning to hospital after head injury will require neurosurgery. Where there is good access to computed tomography all patients should probably have a scan unless the initial scan yielded negative results; about 14% can be expected to show an abnormality other than the fracture. Where access to tomography is difficult priority should be given to patients with a skull fracture or objective evidence of intracranial problems (such as focal neurology, depressed score on Glasgow coma scale, or speech

disturbance), or both. This follows accepted guidelines for the initial management of head injuries, applicable to both adults and children.^{10 11} A short period of observation with symptomatic management is reasonable for patients without these markers of particularly high risk, but referral for computed tomography should be given serious consideration if the symptoms do not resolve or show definite improvement within 24 hours after readmission. All reattenders need to be taken seriously.

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Risk score would be more helpful

Gordon Murray

Voss and colleagues describe data which are of considerable interest, and yet I find their paper frustrating in that the analysis and presentation of their data stops just short of what is required to assess the clinical relevance of their findings. Moreover, their conclusions are speculative and go beyond what can be supported by the data as presented in their paper.

The problem being tackled is inherently multivariate (what can be said about an individual patient with a certain set of features and symptoms?) as is the authors' primary analysis, and yet the quantitative presentations of results are all univariate (tables II, III, VI, and VII). The data as presented do not allow one to deduce how many patients had, for example, at least one risk factor for an abnormality on computed tomography, nor can one say anything about the odds ratios for a patient with a certain combination of risk factors. Thus the data give little assistance in the making of management decisions concerning individual patients, and neither do they allow one to assess the properties of a strategy such as "admit and urgently scan all patients with a skull fracture or some objective evidence of intracranial problems, or both."

Both of these issues could have been dealt with very simply. For decision making relating to individual patients the logistic regression analyses could have been reported by giving a risk score which could be translated, for an individual patient, into a probability of having an abnormality on computed tomography or requiring neurosurgical intervention. In terms of assessing a management strategy the authors could have given the numbers of patients flagged as being "at risk" together with the sensitivity and specificity for detecting problems. Several different strategies could have been presented and their performance compared. It would be interesting, for example, to see whether the inclusion of speech disturbance in a decision rule was useful. This feature was significant in both sets of univariate analyses, and yet it seems unlikely that a feature which is present in only 1% of reattenders would be of value in any decision making process.

The estimates of sensitivity and specificity for any such rules would be optimistic because of the circularity of assessing the performance of a rule on the same data set as was used to derive the rule. This would be a particularly severe problem in terms of predicting the requirement for a neurosurgical operation because of

the small number of such procedures in the study population (30). A further prospectively collected data set would be required to give a reliable assessment of performance, but a circular assessment would at least give some indication of whether the features identified by the authors might allow more rational decisions to be made in this difficult clinical area.

Authors' response

Our basic aims in this paper were twofold: firstly, to point out that "comeback" patients are a high risk group in themselves and, secondly, to identify features which might suggest that immediate further investigation or referral should be undertaken. It was intended to be exploratory and descriptive and thus was not formulated as a test of any particular strategy. The idea of presenting the data in a univariate manner was to emphasise the increased risk associated with the presence of certain clinical features in our patients as compared with those who did not have these features. The list of these features was obtained by multivariate analysis but clearly needed separation to allow the relative risk of an adverse outcome to be assessed. We think that the figures as presented give a fairly clear picture to the non-statistician and at the same time have a clear message for the clinician, which is "when confronted by a comeback patient with *any* high risk feature the prudent action is to arrange urgent referral."

We think that the development of yet another risk score would not contribute understanding to the care of the head injured patient, and we are concerned that it may lead to undue reliance on such a score. We think we have made it clear enough that ideally all reattenders should undergo computed tomography but that if this is not practicable then those with any of the risk factors or associated features we identified should be given priority for referral. If "soft" features are persistent one would be most unwise to ignore them, and thus we don't think an algorithm or risk score are more helpful than general clinical advice. The difficulty and validity of developing sensitive and specific rules retrospectively from data which have already been collected is emphasised by the commentator, and we would prefer to leave this task to future researchers to carry out prospectively.

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