

## Clinical predictors of minor head injury patients presenting with Glasgow Coma Scale score of 14 or 15 and requiring neurosurgical intervention

輕微頭部受傷而格拉斯哥昏迷指數 14 或 15 分的病人，需要腦外科介入治療的臨床預報因子

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**Introduction:** Minor head injury is the most common type of head injury assessed in accident and emergency departments. Emergency physicians have concerns in discharging patients with intracranial injuries which require neurosurgical interventions. The aim of this study is to find out the clinical signs and symptoms which can help to predict who need neurosurgical intervention following minor head injury. **Methods:** This was a retrospective case-control study. Patients with head injury and GCS score of 14 or 15 and requiring neurosurgical intervention were recruited. Another group of patients with head injury and GCS score of 14 or 15 but not requiring neurosurgical intervention were enrolled as control. In all cases, clinical signs and symptoms were collected by chart review of the clinical records retrieved by the computerized Clinical Data Analysis & Reporting System (CDARS). The relationship between clinical features and need of neurosurgical intervention was analyzed by chi-square test with 95% confidence interval. **Results:** A total of 22 cases were found and compared with 288 controls to study on the clinical variables for the prediction of the need of neurosurgical intervention. Six warning signs were found statistically significant by univariate analysis: severe headache ( $p=0.0206$ ), vomiting more than once ( $p<0.0006$ ), drop in GCS ( $p<0.0001$ ), confusion/restlessness ( $p<0.0001$ ), bleeding from ear ( $p<0.0001$ ) and skull fracture in the X-ray ( $p<0.0001$ ). **Conclusion:** Patients with minor head injury presenting with GCS score of 14 or 15 to the accident and emergency department rarely require neurosurgical intervention. Some clinical risk factors can be used as a guide to identify those who need neurosurgical intervention following minor head injury. (*Hong Kong j.emerg.med.* 2010;17: 256-261)

**引言：**輕微頭部受傷是急症室最常評估的頭部創傷類別。急症科醫生擔憂離院病人中有顱內創傷而需要腦外科介入治療。本研究旨在找出可以幫助預測輕微頭部受傷後需要腦外科介入治療的臨床徵狀。**方法：**這是一個回顧性個案對照研究。招募格拉斯哥昏迷指數14或15分而需要腦外科介入治療的頭部受傷病人。登記另一組格拉斯哥昏迷指數14或15分但不需腦外科介入治療的頭部受傷病人作對照。審核由電腦「臨床數據分析及報告系統」找出的臨床記錄，收集所有個案的臨床徵狀。以卡方檢驗及95%置信區間分析臨床徵狀的出現與需要腦外科介入治療的關係。**結果：**共找到22個案例與288個對照比較，以研究預測需要腦外科介入治療的臨床變數。單變分析找到6個統計學上重要的預警徵象：劇烈頭痛（ $p=0.0206$ ），多於一次嘔吐（ $p=0.0006$ ），格拉斯哥昏迷指數下降（ $p<0.0001$ ），精神錯亂或不

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安 ( $p < 0.0001$ )，耳內出血 ( $p < 0.0001$ ) 及 X 光顯示顱骨骨折 ( $p < 0.0001$ )。結論：急症室中格拉斯哥昏迷指數 14 或 15 分的輕微頭部受傷病人很少需要腦外科介入治療。可以使用一些臨床風險因素作指引，以識別頭部輕微受傷後需要腦外科介入治療的病人。

**Keywords:** Case-control studies, craniocerebral trauma, neurosurgical procedures, odds ratio

**關鍵詞：**個案對照研究、顱腦創傷、神經外科程序、機會率

## Introduction

The evaluation of patients with head injury is a common exercise for the emergency physician. Minor head injury represents the most common type of head injury assessed in the accident and emergency department (AED), constituting nearly 85% of head injury cases.<sup>1</sup> Minor head injury is commonly defined as Glasgow Coma Scale (GCS) score of 14-15.<sup>2</sup> Although most patients with minor head injury can be discharged without sequelae, a small portion of these patients will deteriorate and require neurosurgical intervention for intracranial haemorrhage. Emergency physicians have concerns in those patients with minor head injury who present with a GCS score of 14-15 but who eventually require emergency craniotomy or other neurosurgical interventions. GCS is widely used for the assessment of head injury, but some authors take the view that this scale is less useful to distinguish the milder types of injury.<sup>3,4</sup> Therefore the aim of this study is to investigate some common clinical findings to identify those patients with minor head injury who are at increased risk of significant intracranial lesions.

## Materials and methods

This was a case-control study conducted in the AED of Kwong Wah Hospital in Hong Kong. The Kwong Wah Hospital has a neurosurgical centre which caters for neurosurgery in the Kowloon West Cluster.

This study was based on retrospective chart review of patients who presented to the AED of Kwong Wah Hospital between 1st January 2004 and 31st March 2009. Eligible patients for the case group included those aged 12 years or above, with initial AED GCS score of 14 or 15, blunt head trauma and neurosurgical

operation performed. Patients below 12, with penetrating cranial trauma or no clear history of trauma as the primary event were excluded from the study. Candidates for enrolment in the study were searched through the hospital electronic record database by the Clinical Data Analysis & Reporting System (CDARS). We searched through the diagnosis of head injury (including brain injury and skull fracture) and operative procedures related to the diagnosis code (including craniotomy, craniectomy, and elevation of skull fracture).

The control group was recruited in the same study site within the period from 1st January to 31st March 2009. It consisted of head injury patients with the same inclusion criteria of the case group except for neurosurgical operation. Patients attending the AED of Kwong Wah Hospital with or without admission were searched using the CDARS. Patients discharged from the AED were assumed to have no clinically important brain injury if they did not re-attend any hospital of the Hospital Authority within seven days of discharge. All case records were retrieved and reviewed by the author. If the patient was admitted, the discharge summary, CT brain report and operation record were reviewed as well. The findings of the neurosurgeons were used to resolve discrepancies in the history and physical examination data.

A literature review of the risk factors associated with the presence of intracranial lesions in minor head injury patients was carried out.<sup>5-7</sup> Clinical symptoms, signs or previous medical conditions were selected as risk factors to be analysed in minor head injury patients in the AED. These factors included age  $\geq 65$  years, severe headache, nausea, vomiting more than once, loss of consciousness (LOC), questionable LOC, post-traumatic amnesia, drop in GCS, confusion/

restlessness, focal neurological signs, bleeding from ear, skull fracture on X-ray, coagulopathy, intoxication and chronic alcohol use.

LOC was coded as questionable LOC, LOC  $\leq$  5 minutes or LOC  $>$  5 minutes because qualified witnesses were not available in most situations to time the period of LOC. This was the most common method of documentation in the medical record. Cranial soft tissue injury was defined as trauma above the eyebrows and included minor lesions such as abrasions and small lacerations. Focal neurological signs were defined as unequal or asymmetrically reactive pupils, nystagmus or other abnormal eye movements, focal limb weakness, or Babinski's reflex. Facial injury was defined as any trauma below the eyebrows. Most patients with coagulopathy took oral anticoagulants.

Data were analysed by using the Number Cruncher Statistical System (NCSS) software 2007. We used univariate analysis to determine the strength of association between each clinical feature and the need for neurosurgical intervention. The relevance of the different variables and their influence on the need for neurosurgical intervention were presented as odds ratio (OR) with 95% confidence interval. We also used simple descriptive statistics to illustrate the prevalence of clinical warning signs in patients requiring urgent neurosurgical intervention.

## Results

A total of 46 cases of head injury with operation done were retrieved from the electronic database, but 24 cases were excluded because the initial GCS was  $<$ 14

(22 cases), wrong coding (1 case) and age  $<$ 12 years old (1 case). The remaining 22 cases were included in the final analysis.

For the control group, a total of 302 patients were retrieved from the electronic database, but 5 cases were excluded as a result of wrong coding and 9 were excluded because the initial GCS was  $<$ 14. A total of 9 cases of re-attendance within seven days were found, and 4 cases were admitted to hospital but subsequent CT brain showed no significant brain injury. Two cases were reassessed in the AED and discharged without subsequent return. Two patients re-attended for complaints not related to the episode of head injury. One patient was called back because of suspected neck injury on the X-ray of the cervical spine, and CT brain after admission showed subdural haematoma. Repeat CT brain showed static haematoma and the patient discharged herself with acknowledge of medical advice. In the control group, 7 patients were found to have intracranial haemorrhage. One had small epidural haemorrhage, 3 had subdural haemorrhage, 2 had subarachnoid haemorrhage and 1 sustained skull base fracture with intracerebral haemorrhage. All recovered with conservative treatment except for one with subdural haemorrhage who discharged himself with acknowledge of medical advice.

Overall, the mean age of the patients was 55 years (range 14-96) and 58% were males. The most common mechanism of injury was "slip and fall" followed by assault.

Table 1 summarises the enrolled patients with significant brain injury. The clinically important brain injuries were not mutually exclusive. Nearly half of the

**Table 1.** Number of clinically important brain injuries

Clinically important brain injury	Intervention	No intervention
Skull fracture	9	1
Epidural haemorrhage	11	1
Subdural haemorrhage	12	3
Subarachnoid haemorrhage	6	2
Intracerebral haemorrhage	5	1
Intraventricular haemorrhage	0	0
Contusion	10	0

patients had more than one clinically important brain injury. Four patients suffered from 3 types of brain injuries.

Table 2 demonstrates the result of the univariate analysis of the association between individual clinical variables and the need for neurosurgical intervention. The variables with strongest association included severe headache, vomiting more than once, drop in GCS,

confusion/restlessness, focal neurological signs, palpable cranial deformity, bleeding from ear and skull fracture on the X-ray.

Table 3 summarises the clinical features of the 22 patients who need neurosurgical intervention. More than 50% of the patients had drop in GCS within 24 hours. Over one-third of the patients experiencing severe headache had skull fracture on X-ray.

**Table 2.** Univariate analysis for need of neurosurgical intervention

Variable	Intervention N=22	No intervention N=288	Chi-square p-value	OR*	95%CI
<b>History</b>					
Age ≥65	10 (45.5%)	102 (35.4%)	0.3448	1.52	0.65-3.56
Sex (M)	21 (95.5%)	160 (55.6%)	0.0003	16.80	2.82-99.31
<b>Mechanism of injury</b>					
Motor vehicle crash	0	4 (1.4%)	0.5780	0	0
Pedestrian struck by car	2 (9.1%)	10 (3.5%)	0.1879	2.78	0.65-12.21
Bicyclist struck by car	0	3 (1.0%)	0.6305	0	0
Assault	2 (9.1%)	43 (14.9%)	0.4536	0.57	0.14-2.28
Slip and fall	11 (50.0%)	129 (44.8%)	0.6361	1.23	0.53-2.87
Fall from height	1 (4.5%)	41 (14.2%)	0.2005	0.29	0.05-1.73
Sports injury	1 (4.5%)	5 (1.7%)	0.3566	2.70	0.40-18.56
Hit by hard object	1 (4.5%)	35 (12.2%)	0.2831	0.34	0.06-2.09
Others	4 (18.2%)	17 (5.9%)	--	--	--
Coagulopathy	1 (4.5%)	3 (1.0%)	0.1604	4.52	0.63-33.51
Intoxication	3 (13.6%)	45 (15.6%)	0.8037	0.86	0.26-2.83
Chronic alcohol use	1 (4.5%)	12 (4.2%)	0.9319	1.10	0.18-6.97
<b>Symptom</b>					
Severe headache	8 (36.4%)	48 (16.7%)	0.0206	2.86	1.16-7.04
Nausea	2 (9.1%)	13 (4.5%)	0.3349	2.13	0.50-9.06
Vomiting >1	6 (27.3%)	19 (6.6%)	0.0006	5.31	1.93-14.76
LOC ≤5 min	1 (4.5%)	17 (5.9%)	0.7930	0.76	0.12-4.73
LOC >5 min	0	17 (5.9%)	0.2411	0	0
Questionable LOC	1 (4.5%)	19 (6.6%)	0.7057	0.68	0.11-4.18
Amnesia	3 (13.6%)	21 (7.3%)	0.2831	2.01	0.59-6.92
<b>Physical finding</b>					
Drop in GCS within 24 hr	12 (54.5%)	0	0.0000	NA	NA
Confusion/restlessness	3 (13.6%)	2 (0.7%)	0.0000	22.58	4.22-119.99
Cranial soft tissue injury	12 (54.5%)	190 (66.0%)	0.2783	0.62	0.26-1.45
Isolated facial trauma	3 (13.6%)	57 (19.8%)	0.4812	0.64	0.20-2.10
Focal neurological sign	1 (4.5%)	0	0.0003	NA	NA
Palpable cranial deformity	1 (4.5%)	0	0.0003	NA	NA
Raccoon eyes	0	2 (0.7%)	0.6950	0	0
Otorrhoea/rhinorrhoea	0	1 (0.3%)	0.7819	0	0
Bleeding from ear	4 (18.2%)	2 (0.7%)	0.0000	31.78	6.30-158.23
Skull fracture on X-ray	8 (36.4%)	2 (0.7%)	0.0000	81.71	17.59-370.05

\*OR=odds ratio calculated by the method of Score (Farrington & Manning)

GCS: Glasgow Coma Scale; LOC: loss of consciousness

**Table 3.** Clinical features of patients who required neurosurgical intervention

Characteristics	No. of patients
Sex (M)	21 (95.5%)
Drop in GCS within 24 hour	12 (54.5%)
Severe headache	8 (36.4%)
Skull fracture on X-ray	8 (36.4%)
Vomiting >1	6 (27.3%)
Confusion/restlessness	3 (13.6%)
Bleeding from ear	4 (18.2%)
Focal neurological sign	1 (4.5%)
Palpable cranial deformity	1 (4.5%)

GCS: Glasgow Coma Scale

## Discussion

Minor head injury is one of the most common traumatic injuries encountered in the AED. Around two-thirds of the patients with head injury are classified as having minor head injury. Less than 10% of the patients with minor head injury have positive findings on the CT scan of the brain and less than 1% of them require surgery.<sup>8</sup> Although the need for surgical intervention in patients with minor head injury is rare, emergency physicians have concerns in failure to identify this group of patients. Several authors have suggested that the best neurological outcomes associated with early CT scan occur in patients who seem to be at low risk but harbour significant intracranial pathology.<sup>9,10</sup> Prevention of their deterioration is of utmost importance.

In this study, the univariate analysis of clinical characteristics revealed many variables associated with the need for surgical intervention. In line with other studies,<sup>6,7</sup> severe headache, vomiting more than once, drop in GCS, confusion/restless, focal neurological sign, palpable cranial deformity, bleeding from ear and skull fracture on the X-ray are significant clinical features for which physicians should be vigilant when assessing patients with minor head injury in the AED. The severity of headache was not defined in this study. It would be difficult to conclude headache as a significant finding, unless we assumed that all documented headache on the clinical records was severe and would alter the evaluation of the patients and the

plan of management. Drop in GCS was one of the most important clinical predictors. It occurred in 54.5% of the patients who required surgical intervention. Unfortunately, it is not the usual presentation when the patient first attends the AED. Therefore, close observation for at least 24 hours, either in hospital or at home, should be mandatory. A reliable caregiver should be available for the discharged patient. Clear written instruction, such as a head injury card, should be given. Patients should be advised to come back should there be any sign of deterioration.

Focal neurological sign was found in only one patient and so was palpable cranial deformity. Although the associations were statistically significant, the results should be interpreted with caution. Skull fracture on the X-ray is another important feature to look for. It was significantly associated with intracranial haemorrhage and the need for surgical intervention. Hence, patients with skull fracture should be advised to proceed with CT imaging for further evaluation of intracranial injury.

Not surprisingly, LOC or amnesia alone is not an important clinical parameter to consider in assessing patients with minor head injury and GCS score of 14 or 15. Erick et al found in their study that the rate of abnormal CT findings for patients with GCS score of 15, history of LOC or amnesia and no symptoms or signs of depressed skull fracture, was very low. None of these patients in their study required medical or surgical interventions.<sup>11</sup> In the National Institute for Health and Clinical Excellence (NICE) guideline updated in September 2007, any amnesia or loss of consciousness since the injury without additional risk factors, namely, age  $\geq 65$ , coagulopathy or dangerous mechanism of injury, does not warrant CT brain scan in the adult population.

For limitations, this study was carried out in a retrospective manner. We had little control over the data collection. Data on the AED record or in-hospital discharge summary might not be complete. The severity of headache could not be defined in advance in this study. Careful attention to the precise definitions of clinical predictors was essential. Also,

the case and control groups were selected from different time periods, selection bias could have occurred. Moreover, not all patients with blunt head injury received head CT. Some of the discharged patients who might have clinically important brain injury and require neurosurgical intervention might visit private hospitals. Their medical records could not be traced. However, as government hospitals catered for most of the tertiary care in Hong Kong, such missed cases were considered insignificant. Furthermore, we could not perform a regression analysis as limited by the sample size and data was available from one centre only. Although this was a relatively small-scale retrospective study, it could serve as a template for further large prospective study for the validation of the risk factors.

In conclusion, patients with minor head injury presenting with GCS score of 14 or 15 in the AED rarely require neurosurgical intervention. We have found several risk factors significantly associated with neurosurgical intervention, namely, severe headache, vomiting more than once, drop in GCS, confusion, bleeding from ear and skull fracture on the X-ray. Emergency physicians should be cautious of these warning signs when assessing patients with minor head injury.

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