An Assessment of Clinical Predictors of Intracranial Head Injury Identified by Computed Tomography Scan

W West[1], D Chambers[1], K Myint[2], D Cornwall[1], J Williams-Johnson[2]

ABSTRACT

A prospective study was done during a six-month period on 104 consecutive patients who were seen at the Accident and Emergency (A&E) Department of the UHWI and referred for CT scans of the head within 24 hours of sustaining head injuries. There were 74 (71.1%) males and 30 (28.8%) females. The mean age for females was 40.6 years and 32.4 years for males. Patients were clinically assessed for the presence or absence of vomiting, amnesia, loss of consciousness. bleeding of ear, nose and throat (ENT) and Glasgow Coma score (GCS).

Negative predictive values were calculated for each parameter individually as well as the combination of all five. The absence of vomiting, amnesia, "loss of consciousness" (LOC) or ENT bleed had negative predictive values of 68%, 73%, 76% and 61.6% respectively. An assessment of Glasgow Coma Scale (GCS) of 15 had a 77.5% negative predictive value. When the history was indeterminate, the negative predictive values were 19%, 25%, 60% and 18% respectively for vomiting, amnesia, LOC and ENT bleed.

When all four clinical indicators were absent in the history and examination and the GCS score 15, the negative predictive value for intracranial injury was 89.4%. In summary, the clinical indicators reviewed, alone or in combination, cannot exclude the presence of intracranial injury.

Evaluación de los Predictores Clínicos de la Lesión Cefálica Intracraneal Identificada Mediante Tomografía Axial Computarizada

W West[1], D Chambers[1], K Myint[2], D Cornwall[1], J Williams-Johnson[2]

RESUMEN

Un estudio prospectivo fue realizado por un período de seis meses, durante el cual 104 pacientes consecutivos fueron atendidos en el Departamento de Accidente y Emergencia (A&E) del HUWI, y referidos para TAC de la cabeza dentro de las 24 horas de haber sufrido lesiones cefálicas. Hubo 74 varones (71.1%) y 30 (28.8%) hembras. La edad promedio de las hembras fue 40.6 años, y la de los varones 32.4. Los pacientes fueron evaluados clínicamente para detectar la presencia o ausencia de vómitos, amnesia, pérdida de la conciencia, sangramiento de garganta, nariz y oído (G.N.O.) y la Escala de Coma de Glasgow.

Se calcularon los valores predictivos negativos para cada parámetro individualmente, así como la combinación de los cinco. La ausencia de vómitos, amnesia, "pérdida de la conciencia" (PDC) o sangramiento G.N.O. tuvieron valores predictivos negativos de 68%,73%,76%, y 61.6% respectivamente. Una evaluación de la Escala de Coma de Glasgow (GCS) de 15 tuvo un 77.5% de valor predictivo negativo. Cuando la historia fue indeterminada, los valores predictivos negativos fueron 19%, 25%, 60% y 18% respectivamente para el vómito, la amnesia, la PDC, y el sangramiento G.N.O. Cuando los cuatro indicadores clínicos estuvieron ausentes en la historia y el examen y la puntuación de CGS, el valor predictivo negativo de la lesión intracraneal fue 89.4%. En resumen, los indicadores clínicos examinados – solos o en combinación, no pueden excluir la presencia de la lesión intracraneal.

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From: [1]Radiology Section, [2]Accident and Emergency Section, Department of Surgery, Radiology, Anaesthesia and Intensive Care, The University Hospital of the West Indies, Kingston 7, Jamaica, West Indies.

Correspondence: Dr WM West, Radiology Section, Department of Surgery, Radiology, Anaesthesia and Intensive Care, E-mail: wayne_west@hotmail.com

INTRODUCTION

It has been estimated that 100 to 300 persons per 100 000 population are seen for minor head injury (MHI) annually in emergency Departments in the developed world (1). It is also a common cause for presentation to Accident and Emergency rooms in Jamaica (2). Computed Tomography (CT) is considered the imaging modality of choice for patients with neurocranial trauma (3–6).

One of the challenges in the management of head injury is determining the best use of CT scans in patients with minor head injury (MHI) which is usually defined as "blunt trauma to the head after which the patient may briefly lose consciousness, may have post-traumatic amnesia or both and may have a normal or minimally altered mental status at presentation" (7, 8). Intracranial complications of minor head injuries have been estimated at 6–10% (9). Several guidelines have been developed to facilitate the efficient use of the modality (10–13). These include the criteria for the use of CT set forth by the Scottish Intercollegiate Guidelines Network (SIGN), the Dutch guidelines on the New Orleans criteria, the criteria proposed by the National Institute for Clinical Excellence (NICE), the Canadian CT head rule and the guidelines proposed by the European Federation of Neurological Societies (EFNS) on both the New Orleans criteria and the Canadian CT head rule.

The guidelines aim to reduce the cost of imaging patients without compromising patient care. Guidelines overlap and most divide patients into groups depending on the presence of certain risk factors which include vomiting, amnesia, loss of consciousness, Glasgow Coma Score (GCS) on examination and ENT bleed (indicative of fracture of the base of the skull). They vary in the restrictions they place on the individual clinical features. The Radiology Department of the Uni-versity Hospital of the West Indies (UHWI) Kingston, Jamaica, provides emergency CT scan service for patients from all government-owned hospitals on the island. Patients from institutions other than the UHWI are routed to Radio-logy via the hospital's A & E Department. The A & E De-partment of the UHWI uses the NICE guidelines in its man-agement protocol for head injuries. We are not aware of the protocols used at the other institutions.

This study was undertaken to determine the negative predictive values of some of the clinical parameters which are usually evaluated in cases of head injury. The study did not influence the established management strategies of the referring A&E Departments but merely recorded the outcome of the decisions taken. It was done prospectively in order to ensure adequate documentation of the clinical features.

METHOD

A medical officer in the A&E Department recorded all patients who were referred for CT scans of the head because of injuries suffered within 24 hours of being reviewed in the A&E Department during the period February 1, 2007 and July 31, 2007. The patients were assessed to determine presence or absence of vomiting, amnesia, loss of consciousness and ENT bleed in the history and the GCS at the time of examination. Patients were placed into one of three categories: yes, no and uncertain with respect to vomiting, amnesia, loss of consciousness and ENT bleed.

Another medical officer in the Radiology Department obtained the CT scan data. Presence or absence of intracranial injury was documented and the negative predictive values obtained individually for each clinical parameter for patients in each of the three categories and also individually for a GCS score of 15. The negative predictive value of the combination of the absence of vomiting, amnesia, loss of consciousness and ENT bleed and a GCS of 15 was also determined.

RESULTS

There were 104 patients identified, comprising 74 males and 30 females. The mean age of the sample was 34.9 years. The mean age for females was 40.6 years and for males 32.4 years. Fifty-nine scans were negative for intracranial injury and 45 were positive.

Intracranial injuries included diffuse axonal injury (DAI), intra-parenchymal haemorrhage, brain contusions, depressed fractures greater than 3 mm in depth and subdural haematomas (Table 1).

Table 1: Intracranial injuries seen on CT scans.

Patient	Gender	Age	Injury
1	f	5	Depressed fracture > 3mm: right parietal bone with associated contusion
2	f	7	Cerebral contusion
3	f	9	Intra-parenchymal haematoma: parietal lobe, contusion
4	f	20	Comminuted fracture: left parietal bone, contusion: left parietal lobe
5	f	22	Subdural haematoma with subfalcine herniation
6	f	34	Intra-parenchymal haematoma: midbrain and left temporal lobe
7	f	35	Diffuse axonal injury
8	f	51	Subdural haematoma: right
9	f	83	Subdural haematoma: right
10	f	86	Subdural: right, fracture: right sphenoid
11	f	94	Subdural haematoma : right
12	f	uncertain	Cerebral contusion, fractures
13	f	uncertain	Intra-parenchymal haematoma: frontal
14	m	8	Subdural haematoma, subarachnoid haemorhage, Cerebral contusions
15	m	8	Depressed Fracture of right temporal bone with associated contusion
16	m	10	Depressed fracture > 3 mm: right parietal bone
17	m	12	Intra-parenchymal haemorrhage: right temporal lobe
18	m	14	Intra-haematomas: bilateral with midline shift,
19	m	16	Depressed fracture > 3 mm: comminuted
20	m	16	Cerebral contusion: right parietal lobe
21	m	19	Cerebral contusions – bilateral, cerebral oedema
22	m	26	Intra-parenchymal haemorrhage: left parietal lobe

Table 1 cont'd: Intracranial injuries seen on CT scans.

Patient	Gender	Age	Injury
23	m	28	Diffuse axonal injury
24	m	28	Epidural haematoma: left, fracture of base of skull
25	m	28	Epidural haematoma, Contusion: Left frontal lobe, Fracture: Lt parietal bone
26	m	30	Intra-parenchymal haematoma.
27	m	32	Epidural haematoma: Right left
28	m	37	Intra-parenchymal haematoma: left frontal lobe
29	m	43	Depressed fracture > 3 mm, subdural haematoma
30	m	43	Diffuse axonal injury, subarachnoid haemorrhage
31	m	45	Diffuse cerebral oedema
32	m	52	Cerebral contusion : right frontal lobe
33	m	52	Subdural haematoma, Intra-parenchymal haematoma
34	m	52	Pneumocephaly, ventricular compression
35	m	60	Subdural haematoma: left, fractures: left temporal and parietal bones
36	m	62	Cerebral contusion, fractures
37	m	63	Subdural haematoma, *contra coupe* contusion
38	m	69	Subdural haematoma, cerebral contusion, cerebral oedema,
39	m	106	Diffuse axonal injury, intra-parenchymal haematomas, subfalcine herniation
40	m	uncertain	Epidural haematoma, Intra-parenchymal bleed
41	m	uncertain	Intra-parenchymal and intra-ventricular bleed
42	m	uncertain	Epidural haematoma
43	m	uncertain	Cerebral contusion: left frontal lobe, fractures: left frontal bone
44	m	uncertain	Depressed fracture >3mm : comminuted right frontal bone fracture
45	m	uncertain	Diffuse axonal injury

Documentation was inadequate with respect to "loss of consciousness" in two patients, ENT bleed in two patients and vomiting in one patient. Amnesia could not be assessed in eleven patients: five, because they were below the age of five-years and in six patients because of coma or other alteration in mental state.

When absent, vomiting, amnesia, LOC and ENT bleed had negative predictive values of 68%, 73%, 76% and 61.6% respectively. A GCS of 15 had a 77.5% negative predictive value. When the history was indeterminate for vomiting, amnesia, LOC and ENT bleed, the negative predictive values were 19%, 25%, 60% and 18% respectively. Absence of vomiting, amnesia, LOC and ENT bleed, with a GCS of 15 had a negative predictive value for intracranial injury of 89.4%. Results are illustrated in Table 2. Ninteen patients denied any history of vomiting, amnesia, loss of consciousness or ENT bleed and had GCS of 15. Seventeen had normal CT scans. The remaining 2 patients had acute subdural haematomas. CT scans were done on these 19 patients either because of their age or the mechanism of injury.

DISCUSSION

Computed Tomography scan is regarded as the modality of choice in managing patients with head injury (4). Its use however consumes both time and financial resources. In order to achieve efficiency in the use of the modality, several guidelines have been recommended. In a recent review of outcomes in 3181 patients utilizing some published national

Table 2: Negative predictive values of clinical parameters used to assess severity of head injury

Clinical feature value	Status	Intracranial Injury True negative	False negative	Negative predictive
LOC	uncertain	6	4	60.0%
	absent	23	9	71.8%
	present	28	32	46.6%
ENT bleed	uncertain	2	9	18.2%
	absent	45	28	61.6%
	present	10	8	55.5%
Vomiting	uncertain	4	17	19.0%
	absent	45	21	68.2%
	present	7	7	50.0%
Amnesia	uncertain	7	20	25.9%
	absent	38	14	73.1%
	present	10	4	71.4%
GCS 15		38	11	77.5%
GCS 15 with normal clinical features		17	2	89.5%

and international guidelines at four Dutch University Hospitals, Smits *et al* concluded that "in order to detect all clinically significant instances of intracranial head injury virtually all patients will have to be scanned" (14). Ibanez *et al* reviewed several clinical indicators of intracranial injury in 1101 patients and found that these parameters could not exclude the presence of injury. They stated that "prediction models built on clinical variables were able to indicate patients with clinically important lesions, but failed to achieve 100% sensitivity in the detection of all patients with CT scans positive for intracranial lesions within reasonable specificity limits" and concluded "Clinical variables are insufficient to predict all cases of intracranial lesions following MHI, although they can be used to detect patients with relevant injuries". These researchers concluded that if all patients with MHI do not have CT scans but are managed using guidelines based on clinical parameters, a rate of misdiagnosis should be assumed.

The present study trends in the same direction. Our assessment of the negative predictive value of some clinical features recommended in the guidelines indicates that absence of loss of consciousness, amnesia, vomiting and ENT bleed are unable, singularly or together with a GCS of 15, to completely exclude the presence of intracranial injury. The evidence appears to suggest that in order to detect all clinically significant head injuries every patient who suffers a minor head injury will have to undergo a CT scan.

Such an approach will result in significant increase in the radiation dose to the population and further increase the cost of healthcare. The most important consideration in management for both the patient and the caregiver is a satisfactory clinical outcome.

Mohanty *et al* (15) have sought to identify a group of adult patients with head injury in whom CT scans were unnecessary. In their study of 348 patients, 12 had abnormal CT scans with no neurological deficits or sequelae and had uneventful discharge without readmission. However, in order to accurately predict outcomes and the need for medical intervention in patients with minor head injury, research in which both clinical parameters and imaging are used to develop predictive models for prognosis must be undertaken. This will simultaneously improve the efficiency in the use of imaging.

REFERENCES

1. Cassidy JD, Carroll LJ, Peloso PM, Borg J, von Holst H, Holm L et al. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. J Rehabil Med 2004; **43 (suppl):** 28–60.
2. McDonald A, Duncan ND, Mitchell DIG, Fletcher PR. Trauma aetiology and cost in the Accident and Emergency Unit of the University Hospital of the West Indies. West Indian Med J 1999; **48:** 141–2.
3. Borg J, Holm L, Cassidy JD, Peloso PM, Carroll LJ, von Holst H et al. Diagnostic procedures in mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. J Rehabil Med 2004; **43 (suppl):** 61–75.
4. Haydel MJ, Preston CA, Mills TJ, Luber S, Blaudeau E, DeBlieux PM. Indications for computed tomography in patients with minor head injury. N Engl J Med 2000; **343:** 100–5.
5. Miller EC, Holmes JF, Derlet RW. Utilizing clinical factors to reduce head CT scan ordering for minor head trauma patients. J Emerg Med 1997; **15:** 453–7.
6. Glauser J. Head injury: which patients need imaging? which test is best? Cleve Clin J Med 2004; **71:** 353–7.
7. Carroll LJ, Cassidy JD, Holm L, Kraus J, Coronado VG. Methodological issues and research recommendations for mild traumatic brain injury: the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. J Rehabil Med 2004; **43 (suppl):** 113–5.
8. Stiell IG, Wells GA, Vandemheen K, Clement C, Lesiuk H, Laupacis A et al. The Canadian CT head rule for patients with minor head injury. Lancet 2001; **357:** 1391–6.
9. af Geijerstam JL, Britton M. Mild head injury: mortality and complication rate – meta-analysis of findings in a systematic literature review. Acta Neurochir (Wien) 2003; **145:** 843–50.
10. Vos PE, Battistin L, Birbamer G, Gerstenbrand F, Potapov A, Prevec T et al. EFNS guideline on mild traumatic brain injury: report of an EFNS task force. Eur J Neurol 2002; **9:** 207–9.
11. Yates D, Breen K, Brennan P, Cartlidge N, Carty H, Chater N et al; for the Guideline Development Group. Head injury: triage, assessment, investigation and early management of head injury in infants, children and adults. National Institute for Health and Clinical Excellence Web site. http://www.nice.org.uk/. Published June 25, 2003.
12. Teasdale G, Gentleman D, Andrews P, Blaiklock C,Cruickshank E, Donnelly T et al; for the Guideline Development Group. Early management of patients with head injury. Scottish Intercollegiate Guidelines Network. http://www.sign.ac.uk/guidelines/fulltext/46/index.html; http://www.sign.ac.uk/guidelines/published/index.html. Published August 2000. Updated December 11, 2001.
13. Ingebrigtsen T, Romner B, Kock-Jensen C. Scandinavian guidelines for initial management of minimal, mild, and moderate head injuries. J Trauma 2000; **48:** 760–6.
14. Smits M, Dippel DJW, de Haan GG, Dekker HM, Vos PE, Kool DR et al Minor Head Injury: Guidelines for the Use of CT – A Multicenter Validation Study.
15. Mohanty SK, Thompson W, Rakower S. Are CT scans for head injury patients always necessary?. Neurosurg Clin N Am 1991; **2:** 321–39 1991 **31:** 801–4 discussion 804–5.