ORIGINAL ARTICLE

NICE guideline for the management of head injury: an audit demonstrating its impact on a district general hospital, with a cost analysis for England and Wales

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Objectives: To answer concerns related to implementation of the National Institute for Clinical Excellence (NICE) guideline on the management of head injury by determining the impact on the workload of a district general hospital. Increased computed tomography (CT) was of particular concern (cost, radiation risk, and delivery constraints).

Method: Retrospective audit of all patients attending the hospital's emergency department with a head injury over a three month period. Any reattendees for the same head injury episode were excluded but the need for CT was recorded. Case notes and electronic records were reviewed to determine whether the CT head or skull radiograph (SXR) was indicated in line with the NICE guideline. The workload was compared with an identical audit performed before the implementation of the NICE guideline.

Results: Of 17 472 patients attending the ED in 2004, 472 had a head injury. CT scan was indicated in 36, a significant increase from 2003 ($p<0.001$). No SXR was indicated but two were performed, a significant decrease ($p<0.001$). The admission rate was unaltered. The positive predictive value of NICE was 17.1% compared with 25% (p = not significant) for the authors' pre-NICE departmental guideline.

Conclusions: This department has seen an increase in CT head requests since the implementation of the NICE guideline. This costs an extra £15 000 per 100 head injuries annually for this department, with an estimated £51.7 million burden for England and Wales. Further evaluation is required as there were only nine brain injuries in this audit population.

In June 2003, the National Institute for Clinical Excellence (NICE) published clinical guidelines for the management of head injury.[1] This encompasses triage, assessment, investigation, and early management of head injury in all age groups. The primary concern is ''clinically important brain injury''.

Many opinions have been voiced over the introduction of this guideline[2] (hitherto referred to as NICE^{HI} guideline). These include:

- the predicted increase in the number of head computed tomographs (CT)
- questions about whether this demand can be delivered by underresourced radiology departments
- risk for patients with the anticipated increased radiation exposure as a result of additional CT use
- and not least whether the National Health Service (NHS) can meet this added financial burden.

The present audit aimed to determine the impact of the NICE^{HI} guideline on our emergency department (ED).

METHODS

This retrospective audit was carried out at Barnet District General Hospital, London. The hospital serves a population of approximately 250 000 and the ED sees 65 000 patients per annum. The catchment areas included urban areas of north London and semi-urban/rural areas of Hertfordshire. The inclusion criterion was any patient who had attended the ED with a head injury. We defined ''head injury'' as any trauma to the head except superficial injuries to the face. Any patient episode that was a reattendance was excluded but the need for CT was noted. The audit covered a three month period (1 June to 31 August 2004). The cases were identified from the ED computer system (Footman-Walker Associates Ltd, Ringwood, Hampshire, UK) and all requests for CT head scans and skull *x* rays (SXR) were checked to ensure full capture. We identified 472 cases and reviewed the case notes and electronic medical records to determine whether the CT or SXR had been requested within the existing NICE^{HI} guideline. Patient age, sex, time of arrival, day of arrival, mode of arrival, disposal, and reattendance were recorded. Glasgow Coma Scale (GCS) score and the risk factors indicating CT were noted. An identical audit of 520 patients had been performed one year earlier and was used for direct comparison.[2]

Statistical analysis

We compared the two audit populations using the χ^2 test (with continuity correction). Fisher's exact test was used as dictated by small expected cell values. The positive predictive value (PPV) of the NICE^{HI} guideline for CT scans as an indicator for brain injury was estimated with 95% confidence limits.

RESULTS

A total of 17 472 patients attended the ED during the period reviewed, and there were 472 head injuries (male: 271 (57.4%), female: 201 (42.6%)) (table 1). Of these, 308 head injured patients (65.3%) attended out of hours. A total of 36 (7.8%) patients had a head CT scan according to the NICE^{HI} guideline (table 2). This is greater than in the preceding audit (7.8% *v* 2.3%, respectively; χ^2 test $p = 0.0002$).

Abbreviations: CT, computed tomography; ED, emergency department; GCS, Glasgow Coma Scale; NICE, National Institute for Clinical Excellence; PPV, positive predictive value; SXR, skull *x* ray

Table 1 Audit population. The groups were similar (χ^2 test, p = 0.683)

	Groups (by age range)									
	<6 years		6–15 years		16–64 years		>65 years		Total	
	Count	% within	Count	% within	Count	% within	Count	% within	Count	% within
2003	144	27.7	72	13.8	222	42.7	82	15.8	520	100
2004	119	25.2	75	15.9	207	43.9	71	15.0	472	100
Total	263	26.5	147	14.8	427	43.4	153	15.3	992	100

Table 2 Head injury activity at Barnet Hospital before and after implementation of the NICE guideline for head injury

	2003 (pre-NICE)	2004 NICE	p value
Total no. of head injuries	520	472	
Total no. of CT scans performed	12	36	0.0002*
No. of normal CT scans	9 (75%)	30 (83.3%)	
No. of head injuries out of hours	347	308	
Proportion of CT scans out of hours	77.8% (7/9)	73.3% (22/30)	>0.99† ns
Total no. of skull *x* rays taken	59	2	0.0002†
No. of admissions	40	44	0.42*ns
Average admission length of stay (days)	3.85	3.86	
Patients with normal CT findings admitted	8/9	18/30	
Reattendance figure (rate)	4 (0.8%)	13 (2.8%)	0.0307†
Patients arriving by ambulance	196 (37.7%)	153 (32.4%)	0.0946*ns

Significant difference at p<0.05: *χ^2 test; †Fisher's exact test
ns, not significant.

Of the 36 CTs done in 2004, 14 (38.9%) were requested during normal working hours (defined as 9am – 5pm, Monday–Friday). The number of out of hours requests for CT increased in 2004 (22 compared with 7 in 2003) but the proportion of out of hours CTs barely changed (77.8% in 2003 and 73.3% in 2004; Fisher's exact test, p>0.99).

As shown in table 2, the number of admissions did not change significantly after the NICE[HI] guideline was implemented (p = 0.42), and the average length of stay also did not change. There was a decline in SXR use (0.4% NICE[HI] compared with 11.7% in 2003, p<0.0002). Two patients had an SXR but these were not indicated according to the NICE[HI] guideline. The number of patients arriving by ambulance did not change (32.4% NICE[HI] compared with 37.7% in 2003, p = 0.0946), although the rate of re-attendance of head injured patients increased (2.8% compared with 0.8% in 2003, p = 0.0307). All patients who reattended sought reassurance for the vague symptoms following their head injury, and were discharged with appropriate counselling.

The PPV was not significantly different between the two audit populations (χ^2 test, p = 0.671; table 3). We explore this further below.

DISCUSSION

In 2003, NICE issued a guideline for head injury management in the UK. These lowered the threshold for CT scanning of patients with mild head injury and sidelined the use of SXR. A significant increase in rate of CT scanning was anticipated. Assessment of the increased workload was initiated in many hospitals before implementation of the guideline. A medium sized ED was estimated to request an additional 48[2] to 725[3] CT head scans per annum. At Addenbrooke's Hospital, the Canadian head CT rules were implemented before publication of the NICE[HI] guideline[4] and reported a huge reduction in SXR and modest increases in CT and admission rates.

Our audit showed that our rate of CT requests increased threefold (36 compared with 12 in 2003; see table 2). Just over two thirds (73%) occurred out of hours, which has

Table 3 How good is the NICE CT scanning guideline for head injuries at detecting a brain injury compared with our pre-existing departmental guideline?

	2003 (pre-NICE guideline)		2004 (NICE guideline)	
	CT indicated	Not indicated	CT indicated	Not indicated
CT result				
Brain injury	3	0*	6	0*
Normal	9	508*	30	436*
	2003 (pre-NICE)	95% CI	2004 (NICE)	95% CI
Sensitivity (%)	100*	29.24 to 100*	100*	54.08 to 100*
Specificity (%)	99.4	96.72 to 99.2*	93.8*	90.94 to 95.61*
Positive predictive rate (%)	25	5.49 to 57.19	16.7	6.37 to 32.81
Negative predictive rate (%)	100*	99.28 to 100*	100*	99.16 to 100*

*Assumption that all head injuries that resulted in a CT not being indicated would be normal scans. The positive predictive value is the only true value that can be calculated in this audit.

Box 1: Pre-existing guideline (based on the Royal College of Radiologists, 1998) for CT scan requests (pre-NICE 2004 guideline)

The indications for emergency CT include:

- Altered conscious level (GCS 12 or less)
- GCS 13–14, not improving after four hours observation
- Deterioration of GCS by 2 points
- Coma/failure to respond after adequate resuscitation
- Unexplained confusion/irritability for over 4 hours
- Severe headache or vomiting for over 6 hours after trauma
- Skull fracture with any alteration to GCS
- Possible cerebrospinal fluid leakage
- Proven penetrating wounds or depressed fracture
- Fits or focal neurological signs after trauma
- Multiple injuries especially if patient requires ventilation
- Suspected subarachnoid haemorrhage

challenged the NICE[HI] guideline expectation to perform the CT within one hour of the request. On reassessing these 36 cases, 15 CTs would have been indicated using our pre-existing departmental guideline for CT (box 1), which is based on the recommendations of the Royal College of Radiologists.[5] We did not look at whether out of hours requests take longer. The use of ''vomiting'' and ''dangerous mechanisms of injury'' as a criteria for CT scanning were the main causes for this trend and has been highlighted as a potential problem in children.[6]

The use of SXR has dramatically reduced. Of the two performed in the audit period both were not indicated by the NICE[HI] guideline and in retrospect were unnecessary. Their use was to reassure the patient or relatives. This may be the cause of the increased reattendance rate after implementation of NICE[HI] guideline. Prior to this patients with minor head injuries left our department with the reassurance of a normal SXR. In our re-audit we have seen patients after a head injury attending with vague symptoms looking for reassurance. This indicates a clear responsibility to educate patients adequately about the symptoms of head injury before discharge. We must state that the outcome measure for reattendance was patient re-presentation to our department for the same head injury episode. This will miss attendances at other departments, a problem noted by Dunning.[7] No reattendee required a CT head.

NICE anticipated that its guideline would introduce a cost neutral change. Increased CT scanning would be balanced by reduced admissions. Our figures do not support this statement; 18 of the 30 patients with normal CT scans were admitted (see table 2). If the pre-existing guideline had been used 15 scans would have been requested (table 4). The average length of stay was similar between the audits. It can be argued that all patients who, following the NICE[HI]

Table 4 CTs performed after implementation of the NICE[HI] guideline for head injury, and whether they would have been done according to the pre-existing guideline

No.	Age in years	Risk factors according to NICE	CT scan findings	Disposal	Would CT be indicated using our pre-existing guideline	
					Yes/no	Reason
1	25	Focal neurology, GCS 11	Brain injury	Admitted	Yes	GCS 11
2	80	Post-traumatic seizure, GCS 12	Brain injury	Admitted	Yes	GCS 12
3	8	DMI and LOC, GCS 13	Brain injury	Admitted	Yes	Not improving GCS
4	73	DMI and LOC, GCS 14	Brain injury	Admitted	Yes	Confusion
5	21	DMI and LOC, GCS 15	Brain injury	Admitted	Yes	Severe headache
6	28	Focal neurology, GCS 15	Brain injury	Admitted	Yes	Focal neurology
7	77	DMI and LOC, GCS 13	Normal scan	Admitted	Yes	Not improving GCS
8	3	DMI and LOC, GCS 13	Normal scan	Admitted	Yes	Not improving GCS
9	12	>1 episode of vomiting, GCS 14	Normal scan	Admitted	Yes	Confusion, vomiting
10	67	GCS 13/14 at 2 hours after injury	Normal scan	Admitted	Yes	Not improving GCS
11	43	DMI, LOC and vomiting, GCS 15	Normal scan	Admitted	Yes	Persistent vomiting
12	3	GCS 13/14 at 2 hours, GCS 14	Normal scan	Admitted	Yes	Not improving GCS
13	8	Episodes of vomiting, GCS 14	Normal scan	Admitted	Yes	Confusion, vomiting
14	29	Post-traumatic seizure, GCS 14	Normal scan	Admitted	Yes	Seizure
15	11	Vomiting, blurred vision, GCS 15	Normal scan	Admitted	No	
16	17	Post-traumatic seizure, GCS 15	Normal scan	Admitted	Yes	Seizure
17	45	>1 episode of vomiting, , GCS 15	Normal scan	Discharged	No	
18	50	GCS 13/14 at 2 hours after injury	Normal scan	Discharged	No	
19	84	DMI and on warfarin, GCS 15	Normal scan	Admitted	No	
20	42	DMI and LOC, GCS 14	Normal scan	Admitted	No	
21	13	DMI and LOC, GCS 15	Normal scan	Admitted	No	
22	59	DMI and LOC, GCS 15	Normal scan	Admitted	No	
23	24	DMI and LOC, GCS 15	Normal scan	Admitted	No	
24	38	DMI and LOC, GCS 15	Normal scan	Discharged	No	
25	19	DMI and LOC, GCS 15	Normal scan	Discharged	No	
26	18	DMI and LOC, GCS 15	Normal scan	Discharged	No	
27	19	DMI and LOC, GCS 15	Normal scan	Discharged	No	
28	28	DMI and LOC, GCS 15	Normal scan	Discharged	No	
29	15	DMI and LOC, GCS 15	Normal scan	Discharged	No	
30	33	DMI and LOC, GCS 15	Normal scan	Discharged	No	
31	42	DMI and LOC, GCS 15	Normal scan	Discharged	No	
32	60	DMI and amnesia, GCS 15	Normal scan	Admitted	No	
33	13	DMI and amnesia, GCS 15	Normal scan	Discharged	No	
34	13	DMI and amnesia, GCS 14	Normal scan	Admitted	No	
35	19	DMI and amnesia, GCS 14	Normal scan	Admitted	No	
36	20	DMI and amnesia, GCS 14	Normal scan	Admitted	No	

DMI, dangerous mechanism of injury; GCS, Glasgow Coma Scale; LOC, loss of consciousness.

guideline, underwent a CT scan which was normal, may have been admitted if no CT was indicated using the pre-existing guideline. Extrapolating this from table 2 the average length of stay would rise from 3.86 days to 4.11 days. This will not affect the economic analysis.

Assessing the cost benefit of the NICE[HI] guideline the overall annual cost is greater, £15 278 per 100 head injured patients for our hospital. Our Trust is a Public Finance Initiative (PFI) which has higher prices than those quoted by the NICE economic analysis.[1] If one takes these prices for CT, SXR, and admission it is possible to estimate the increased national burden that the NICE[HI] guideline may incur. In England and Wales there are an estimated 700 000 attendances per year for head injury.[8] Assuming our practice is mirrored in other trusts the possible increased revenue required to support the NICE[HI] guideline would be £51.7 million (range 31.5–75.5 million) (table 5). A study from Leeds has projected an increase spend of £27 480 per 100 head injured patients (based on a one month population of 393 head injuries costing an estimated £9000 per month).[9] This projection would take the possible burden nearer the upper limit of £75.5 million.

Attention must be focused on increased patient risk. Radiation exposure has increased 2.6 times using the NICE[HI] guideline (allowing CT = 2 mSv, SXR = 0.06 mSv[5])We are in agreement with the NICE document[1] and have found no evidence in the literature that would support any untoward hazard from this increased CT radiation exposure. Other risks might include anaesthetic and airway hazards. This would be a potential cause of concern if performed in order to facilitate an early CT. However, no problems were identified in our audit population.

Our audit has enabled us to compare the effectiveness of the NICE[HI] and our pre-existing guideline, specifically the question, ''When a CT scan is indicated by the guideline will it be positive for a brain injury?''. The PPV of the NICE[HI] guideline was 16.7% (CI 6.37% to 32.81%) compared with 25% (95% CI 5.49% to 57.19%) for the pre-existing guideline. To this end the NICE[HI] guideline has offered no advantages over our pre-existing guideline other than providing clinicians better leverage to request a CT scan. Conversely with such small numbers of brain injury in our audit populations we cannot state that our pre-existing guideline is any better (as seen by the wide confidence intervals). An obvious weakness is our inability to comment on the negative predictive value. Table 3 shows the theoretical test values which assume a normal CT when a CT was not indicated.

Table 4 shows where the two guidelines differ. Of the 21 disparate episodes two were cases with two episodes of vomiting. With judicious observation, CT scans would have been avoided. The other 19 cases involved ''dangerous mechanisms of injury'' plus another factor. Thirteen were associated with ''loss of consciousness''. We must ask whether the unwitnessed subjective description of loss of consciousness is sufficient to indicate a CT or should it also be linked to another risk factor such as severe headache which is arguably more objective? The remaining five of 19 cases were associated with ''amnesia'' and all were admitted. There was speculation that the NICE[HI] guideline will encourage greater use of an overused ambulance service,[3] but our figures do not support this.

All retrospective studies have limitations. The case notes we have reviewed may have been incomplete. It is possible that further CTs would have been requested under the pre-existing guideline criteria, reducing the cost/analysis/risk evaluation. No CT request was rejected but we have not looked at the delay to CT scan. If may be that delayed CT delivery is attributable to sustained admission rates. Our

Table 5 Cost benefit analysis by extrapolating our audit results to the NICE economic analysis

	NICE economic analysis			2003 (Before NICE (pre-existing guideline))				2004 (NICE guideline)				
	Price (£)				Cost (£)				Cost (£)			
	High	Medium	Low	No.	High	Medium	Low	No.	High	Medium	Low	
Computed tomography (head)	250	160	60	12	3000	1920	720	36	9000	5760	2160	
Skull x ray	45	26	14	59	2655	1534	826	2	90	52	28	
Admission	290	200	150	154 days	44 660	30 800	23 100	170 days	49 300	34 000	25 500	
											Difference per 100 head injured patients (£)	
											High	Medium Low
Annual cost based on audit figures per 100 head injured patients					38 704	26 349	18 958		49 483	33 739	23 464	10 779 7390 4506
Assuming England and Wales see 700,000 head injuries/year:												75 454 433 51 728 266 31 541 617
Projected extra annual funding required to support NICE head injury guideline (£)												

pre-existing guideline often asks to observe for longer periods before requesting a CT; this wait may be a cause of greater patient morbidity despite correctly indicating the need for a scan. Our audits contained only nine patients with brain injury, therefore a true evaluation of the NICE[HI] guideline as a screening tool requires further study.

A prospective study looking at these factors should further delineate the risk for patients and quantify service gaps in our radiology services such as CT availability, particularly out of hours. Until these are known Barnet will continue to implement the NICE[HI] guideline.

CONCLUSION

The present audit compared the provision of CT imaging in head injured patients as indicated by our pre-existing departmental guideline and that introduced by NICE in 2003. No patient with brain injury was missed with either guideline (assuming when a CT was not indicated a brain injury did not exist). In our hospital, there is clear evidence that NICE[HI] has brought greater expense and increased the radiation exposure of patients. There is no evidence that admissions have been reduced. Compared with our pre-existing guideline, the NICE[HI] guideline is not cost beneficial. Further evaluation is required.

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REFERENCES

1 **National Institute for Clinical Excellence**. *Head Injury. Triage, assessment, investigation and early management of head injury in infants, children and adults*, Clinical Guideline 4. Developed by the National Collaborating Centre for Acute Care. London: NICE, 2003.
2 **Shravat BP**, Hynes KA. The impact of NICE guidelines for the management of head injury on the workload of the radiology department. *Emerg Med J* 2004;**21**:521–2.
3 **Leaman AM**. The NICE guidelines for the management of head injury: the view from a district hospital. *Emerg Med J* 2004;**21**:400.
4 **Sultan HY**, Boyle A, Pereira M, *et al*. Application of the Canadian CT head rules in managing minor head injuries in a UK emergency department: implications for the implementations of the NICE guidelines. *Emerg Med J* 2004;**21**:420–5.
5 **The Royal College of Radiologists**. *Making the best use of a department of clinical radiology, guidelines for doctors,* 4th edn. London: Royal College of Radiologists, 1998:74–6.
6 **Dunning J**, Daly JP, Malhotra R, *et al*. The implications of NICE guidelines on the management of children presenting with head injury. *Arch Dis Child* 2004;**89**:763–7.
7 **Dunning J**, Lecky F. The NICE guidelines in the real world: a practical perspective. *Emerg Med J* 2004;**21**:404–7.
8 **The Royal College of Radiologists**. *Making the best use of a department of clinical radiology, guidelines for doctors,* 5th edn. London: Royal College of Radiologists, 2003:96.
9 **Lee JB**. NICE head injury guidelines: cost implication for a district general hospital. *Emerg Med J* 2004;**21**:125–6.