ORIGINAL ARTICLE

Evaluation of the impact of the Canadian CT head rule on British practice

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Background: The Canadian CT head rule has been developed to identify which adults with minor head injuries require computed tomography (CT). This is hoped will reduce the number of CT scans performed for minor head injury in North America. It was unclear whether applying the rule would reduce or even increase the number of CT scans requested in UK emergency departments.
Methods: A retrospective evaluation was conducted of all adults who presented after minor head injuries to Addenbrooke's emergency department. Clinical information about patients with head injuries is collected on standardised forms. A dataset was constructed to predict how many patients would require head CT scans if the Canadian CT rule was applied.
Results: 1489 adults presented after minor head injury over a seven month period. Seventy four of these had CT scans for head injury, applying the Canadian CT head rule would have resulted in 132 CT scans being requested. This is significantly more ($p>0.001$). This would have resulted in a 68% increase in costs.
Interpretation: The Canadian CT head rule would result in an increase in the number of CT scans requested for minor head injuries. This increased cost must be considered against the 488 skull radiographs that were requested during the study period.

Identification of patients who have intra-cranial haematomas after a minor head injury is a difficult and common problem. The Canadian CT head rules have been published as a guide to predict which patients have clinically important injuries on CT scan. These are derived from a large, prospective cohort study.[1]

The authors postulate that application of the CT head rules would reduce the requirement for CT in North American emergency departments to 32% of the present level.

It is not clear whether application of this rule would reduce the number of CT scans requested in British hospitals. British practice is based on national guidelines and relies partly on skull radiographs.[2] We wished to see what the impact of applying this rule would be on a single emergency department, seeing 45 000 adult patients a year. The specific null hypothesis that we tested was that there would be no difference in the proportion of CT scans actually requested, compared with a hypothetical model created using the recorded clinical variables. We also wanted to know whether the cost of requesting less skull radiographs would offset the possible increased cost of requesting more CT scans.

METHODS

A pilot of one month suggested that we would need 300 cases of head injury to show a significant difference between the Canadian CT head rule and the British guidelines, we estimated that we would see 320 minor head injuries in seven months. Clinical information about patients with head injury is collected on standardised forms in our hospital.

We carried out a retrospective case note review, examining data from hospital notes of adult (over 16 years of age) head injured patients presenting to the emergency department between 1 April 2001 and 1 November 2001. Subjects were selected if the routine departmental coding contained any indication of trauma to the head or face. We also included patients with ''multiple injuries'' as a code.

In addition, we examined all cases who had a had CT scan, regardless of indication, and all cases who had had a skull radiograph to try and identify any other patients with head injury.

We included cases if there was trauma to the head within the past 24 hours in patients resulting in witnessed loss of consciousness or amnesia/disorientation. Patients were excluded if there was no clear history of trauma as the primary event (for example, syncope, primary seizure). Clinical variables identified by the Canadian CT head rule, the Royal College of Surgeons of England national guidelines, and our own practice were collected (see boxes 1 and 2).

We used χ^2 tests for differences between proportions to analyse categorical data. Stata statistical software version 7 was used to analyse the data.

RESULTS

Altogether 1489 case notes were examined. Twenty one cases were excluded because it was not clear whether there had been loss of consciousness or amnesia related to trauma within 24 hours of presentation. A total of 1084 cases had not lost consciousness or been amnesic as a direct result of trauma within 24 hours of presentation and were excluded from the analysis. This left 384 cases, any case with missing data was excluded, which left 363 cases. Analysing the

Box 1 Clinical variables identified by the Canadian CT head rule as predicting clinically important brain injury

- GCS score <15 at two hours after injury
- Suspected open or depressed skull fracture
- Any sign of basal skull fracture (haemotympanum, ''racoon'' eyes, CSF otorrhoea, rhinorrhoea, Battle's sign
- Vomiting two or more times
- Age more than 64 years

Box 2 Clinical variables recommended by British guidelines for CT scanning after head injury

- Confusion (GCS<13–14) or worse, persisting after initial assessment and resuscitation
- Unstable systemic state
- Fully conscious but with skull fracture or after a first fit

dataset with or without missing data made little difference to the overall conclusions or the results.

In this series, 74 (20.38%) CT scans were requested, 31 of which were abnormal. If we had used the British guidelines for obtaining CT scans, 91 (25.2%) scans would have been requested. Using the Canadian CT head rule we would have requested 132 (36.4%) CT scans (fig 1).

The difference between the proportions of CT scans requested using the Canadian rule and the number requested is significant ($p<0.01$).

All of those that required scanning under the British guidelines were identified as needing a scan by the Canadian rules (tables 1 and 2).

The total is greater than 58 because some patients had more than one indication for a CT scan.

Alcohol intoxication might confound the association between head injury and need for CT and so we analysed the data without those cases where the patient had drunk alcohol before their head injury (see tables 3 and 4 and fig 2).

COST ANALYSIS

Thirty seven of the 74 CT scans were performed outside normal working hours (9 am to 5 pm on Monday or Friday). Neuro-radiographers who are called into the hospital claim a ''call out'' charge, while the radiographers who perform skull radiographs are resident for all other radiographs and are therefore cost neutral. We also assumed that reporting of CT scans and skull radiographs was cost neutral. The cost of a CT head scan within working hours is £15, out of hours the neuro-radiographer ''call out'' fee raises this to £35 pounds. A skull radiograph costs £1. If we had applied the Canadian CT head rule to our population 81 of the 132 CT head scans would have been requested out of hours. The increased cost using the Canadian CT head rule our model was 95%, when the cost of skull radiographs was subtracted the overall increase was 68%.

Table 1 Reasons for increased CT scans using the Canadian head rule compared with the British guidelines

Reason for the excess CT scans	Number of excess scans
GCS less than 15 at two or more hours	0
Suspected open or depressed skull fracture	0
Any sign of basal skull fracture	0
Age greater than or equal to 65	16
Vomiting	23
Unstable vital signs	0
Anticoagulation	2
Total	41

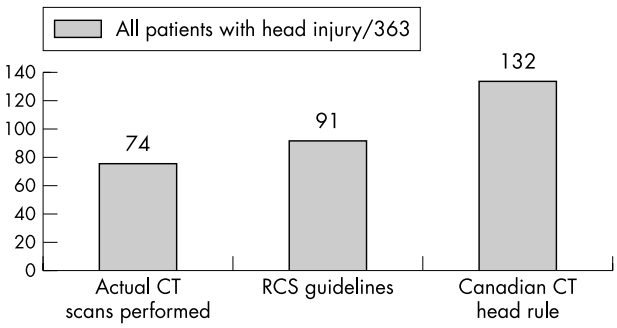

Figure 1 Number of CT scans requested for head injuries compared with predicted using guidelines.

Table 2 Reasons for the excess 58 CT scans using Canadian rules compared with actual requests

Reason for excess scan	Number/58
Reduced GCS	21
Suspected open or depressed skull fracture	8
Any sign of basal skull fracture	1
Age greater than or equal to 65	25
Vomiting	20
Focal deficit	1
Unstable vital signs	1
Anticoagulant use	0
Seizure before assessment	6
Total	83

Table 3 Analysis with patients who had drunk alcohol before their head injury excluded

Clinical guideline	Number of CT scans obtained as proportion of the total sample (%)
Actual scans obtained	57/226 (25.2)
Canadian CT head rule	84/226 (37.17)
British guidelines	62/226 (27.43)

DISCUSSION

Our results show that applying the Canadian CT head rule to a British department would result in 78% more CT head scans being requested than were actually requested. Following the Canadian CT rule instead of the national guidelines would have led to us requesting 45% more CT head scans. The Canadian CT head rule was developed to reduce the number of CT head scans requested for head trauma, it appears that this rule is less useful to British practice than in North America.

This will result in considerably increased costs though these costs will be less when the cost of not requesting skull radiographs is subtracted. The main clinical variables that lead to an increased number of CT scans are age >64 years and vomiting more than twice. These variables had the greatest value in predicting clinically important brain injury, after reduced GCS and any sign of basal skull fracture in the original paper.[1]

There are some limitations to our study. It is not clear whether the group who were not scanned, but would have been scanned under the Canadian CT head rule, had intracranial haematomas that were missed. A prospective study would be needed to identify these patients.

Whether implementing the Canadian CT head rule would lead to more intracranial haematomas being identified is unclear. Bramley *et al* showed that the liberal use of inpatient observation was associated with a very low rate of patients with missed treatable intracranial haematomas being sent home in Scotland (1 in 10 000/year).[3] It is also unclear whether applying the Canadian CT head rule instead of

Table 4 Analysis with patients who had drunk alcohol before their head injury excluded

Variables tested	Number of scans obtained/226	p value
Actual compared with British guidelines	57 *v* 62	0.59
Canadian CT head rule compared with British guidelines	84 *v* 62	<0.01
Canadian CT head rule compared with actual	84 *v* 57	<0.01

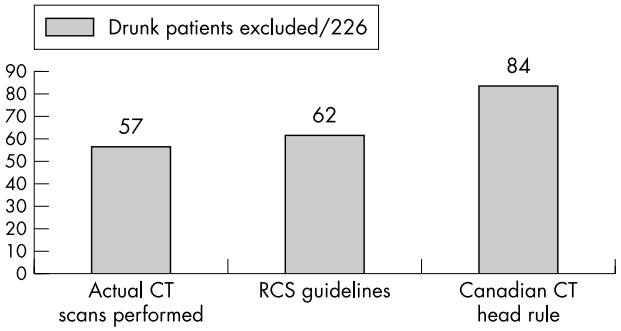

Figure 2 Number of CT scans requested for head injuries compared with predicted using guidelines, excluding patients who had drunk alcohol before their injury.

observation would be cost effective. In our series 124 of 363 patients were admitted for observation. Whether some of these admissions could be reduced by more CT is unclear.

The data were retrospectively obtained by case note review and this might be expected to fail to record important clinical variables. The standardised forms that are used to collect data on head injury patients in our hospital ensured that there were not enough missing data to act as a source of bias. The coding system that we used to identify our head injury cases may not have recorded all the cases of head injury in our study. However, we believe the dataset that we have created is an accurate reflection of the patients with head injury that we saw in the department during the time of the study. Not all our patients presented within two hours of injury and we accept there may be some error around the variable ''reduced GCS at two hours'' though significant bias is unlikely. Indeed, such measurement bias is likely to bias against an increased number of CT scans. There are also limitations to the cost analysis. There are many factors that would change the cost analysis. Clinicians might be more prepared to discharge patients if they knew that the CT scan of the patient was normal. Conversely, confused patients might be kept for a short period of observation despite a normal CT scan, because of worries about safety. Clinicians also might delay a CT scan on a patient seen in the early morning until office hours.

It is interesting that we did not seem to be completely following the British guidelines about obtaining CT scans. This partially reflects the alcohol intoxicated head injured patient who may, quite reasonably, be observed while sobering up. This may account for part of the difference, while the variable approach of individual clinicians may explain the difference. Some clinicians and radiologists advocate early CT scan for head injured patients, while others may adopt a more conservative approach permitting a short period of observation. The retrospective nature of this study does not allow us to identify how much clinician and radiologist individual practice affects head CT.

CONCLUSIONS

The Canadian CT head rule is the strongest evidence we have to guide identification of clinically important abnormalities in head injured patients. Adoption of this rule in British departments will result in an increased number of CT scans being requested, whether this will lead to a benefit in the management of head injuries in the UK is unclear.

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