

Title Page

Computed Tomography for Head Injuries in Children: Change in Australian Usage Rates over Time

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EO designed the protocol, TH, EO and KJ designed the data collection tool, KJ performed the statistical analysis. All authors contributed to data collection and the writing of the article.

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Simon Craig, Stuart Dalziel, and Franz Babl are Section Editors, Paediatric Emergency Medicine, for Emergency Medicine Australasia, Jeremy Furyk is Section Editor, From Other Journals, for Emergency Medicine Australasia.

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Abstract

Introduction

Paediatric Head injury is a common presentation to the emergency department (ED). North American studies demonstrate increasing use of computed tomography brain scan (CTB) to investigate head injury. No such data exists for Australian EDs.

Objective

To describe CTB use in head injury over time in eight Australian EDs.

Design

Retrospective emergency department electronic database and medical imaging database audit was undertaken for the years 2001-2010 by International Classification of Diseases (ICD) 9 or 10 code for head injury in children <16 years.

Setting

Emergency and medical imaging departments of eight hospitals in Australia (5 tertiary referral and 3 mixed departments)

Outcome measures:

Data for ED presentations with head injury, and all CTB performed by medical imaging were merged to obtain a dataset of CTB performed within 24 hours for head injury-related attendances to the ED. Descriptive and comparative analysis of CTB rates was performed.

Results

The rate of CTB over the decade was 10.2% (95% CI 9.9%, 10.5%). The annual rate varied from 9.5% (95% CI 8.2%, 10.9%) to 12.5% (95% CI 11.2%, 13.9%). CTB use did not increase over time. Median year of age at time of CT scan was 4 years with an interquartile range (IQR) of 1.5 – 9.4 years. Overall there was a 9.2% increase in the CTB scan rate for every additional year of age at presentation (95% CI 6.6%, 12.1%; $p < 0.001$)

Conclusion

CTB use in head injuries did not increase during the study period, and rates of CTB were less than reported for North America

Author

Introduction

Paediatric head trauma is a common presentation to the Emergency Department (ED). Most injuries follow a benign course, with less than one percent of patients requiring neurosurgical intervention (1, 2)

Computed Tomography (CT) scanning provides fast and accurate diagnosis of clinically important traumatic brain injury. CT scan use for the investigation of head injury has increased significantly over the last 10 to 15 years based on overseas data.(3-7) In the United States, around one third of children presenting to the ED with a minor head injury receive a CT brain scan (CTB)(1), with one study reporting that in 2008, 34% of children with minor head injury underwent CTB, compared to only 11% in 1995(8)An increase in CTB scanning rate has also been documented in Canadian EDs, from 15% in 1995 to 53% in 2005(4, 9)

There are concerns about the risks posed by both sedation and radiation exposure associated with CTB. There is evidence from epidemiological studies that radiation doses delivered by a standard CTB result in an increased risk of malignancy with higher risk in younger children(3). A recent Australian cohort study of 10.9 million young people found an increased incidence rate for all types of cancer in those who were exposed to CT scanning compared to those not exposed (incidence rate ratio 1.24)(10).

Clinical decision rules have been developed overseas to help minimise CT use in children with head injury (2)They have not been validated in an Australasian population. The local applicability of overseas head injury decision rules will also depend on the baseline rates in the settings where the rules are to be applied. There is some indication from a single centre in Australia that the CT rate for head injuries is lower than in North America. However, the rate of CT scanning for children with head injury across Australasian centres and trends over time are unknown. This paper sets out to determine the rate, and any change in rate of CT scanning in children with head injury in Australasia, over a 10 year period.

Method

Study Design

This was a multicentre retrospective medical record audit based on a review of ED and medical imaging databases.

Setting

This study was performed at 8 hospitals in Australia who are part of the Paediatric Research in Emergency Departments International Collaborative (PREDICT).(11) five of these hospitals were tertiary paediatric hospitals, and three were mixed emergency departments with a high number of paediatric presentations.

Participants

Patients under 16 years of age who presented with a head injury to the ED of participating hospitals between January 2001 and 31 December 2010 were included in the study.

Data Collection

The ED electronic databases were searched using predefined International Classification of Diseases (ICD) 9 and 10 codes that relate to head injury (**Table 1**). Demographic data were obtained including age, gender and Australasian triage score (ATS) category.

Data from CTB were obtained from the hospitals' radiology databases. Data extracted included date of the scan. The ED and radiology databases were then merged to identify patients who presented with head injury and received a CTB within 24 hours.

Approval was obtained from the Ethics committees from each site prior to study commencement.

Statistical Analyses

Descriptive statistics were used for demographic data, CT rates and radiation doses. Key percentages are presented with 95% confidence intervals (CI) and compared using Poisson regression accounting for the non-independence of scan rates occurring at the different hospitals. All statistics were calculated with Stata 12.0 (StataCorp, College Station, Texas, USA).

Results

Demographics

Data were available from eight hospitals for variable periods of the study years due to differing availability/accessibility of relevant ED or medical imaging databases (**Table 2**). Males accounted for 62% of ED presentations for head injury, a proportion that was stable across the years and across age groups. As well as being less likely to attend hospital with a head injury, females were also less likely to have a CTB performed for any HI-related ED attendance (-24.6%, 95% CI -31.5%, -17.1%, $p < 0.001$). Median year of age at time of CT scan was 4 years with an interquartile range (IQR) of 1.5 – 9.4 years

As shown in **Table 2** CT scan rates overall were essentially unchanged over the study period (-1.7%, 95% CI -6.1%, 2.9%; $p = 0.457$). The CTB rate at the tertiary hospitals averaged 9.1% (6.2%, 13.4%) while at the non-tertiary sites averaged 15.9% (13.8%, 18.4%) with the trend for rate at each site similar over time.(Figure1)

There is a decline in ED presentations for head injury with increasing age, but overall, there was a 9.2% increase in the CTB scan rate for every additional year of age at presentation (9.2%, 95% CI 6.6%, 12.1%; $p < 0.001$). (Figure 2)

Discussion

The key findings of this multicentre Australasian study is that the CT scanning rate for children with head injuries has been remarkably stable over the 10 year study period. In addition, the overall CTB scanning rate (10.2%) is substantially lower than data from North America.

The CTB scanning rate our study ranged from 8.6 to 12.5% over the study period. In a study with similar design for 2005 to 2009, Mannix and others(7) retrospectively reviewed patients less than 19 years from 36 hospitals in the United States discharged from the ED after a head injury and found a the median rate of CTB scanning of 36%. These figures do not include those with severe head injury, so can be assumed to underestimate the actual CTB rate. Kuppermann and others(1), for the PECARN research network, prospectively recruited 42,412 children less than 18 years with head trauma between 2004 and 2006. Patients with trivial injuries such as ground level falls were excluded. Overall CTB scanning rate was 35.3%.

Our study demonstrated no change in the rate of CTB scanning for head injury during the study period. By contrast, North American data, shows increasing scanning rates over time(7, 12) In a large network in the United States Larson and others found an increase from 10.9% to 34.0% over the 14 years from 1995-2008 in patients less than 18 years presenting with head injury to hospitals.(8) Blackwell and others describe an increase from 12.8% in 1995 to 28.6% in 2000, with a slight decrease to 22.4% in 2003 in patients under 18 presenting with head trauma(12) Canadian ED CTB rate has also been documented to be increasing - from 15% in 1995 to 53% in 2005.(4)

A recent survey of Australian paediatricians and emergency physicians examined factors contributing to the ordering of CTBs.(13) It was found that Australian practitioners were not using all triggers suggested by existing clinical decision rules(1, 14, 15) when deciding whether or not to perform a CTB. In particular, objective findings such as focal neurology, drowsiness and signs of skull fracture were more commonly used than historical factors such as vomiting, amnesia and mechanism of injury. Factors that have elsewhere been shown to influence the ordering of CTB scanning, including fear of malpractice(16) and parental preference(17) have not been studied in Australian practice.

Like other studies, we demonstrated an increased use of CTB in older age groups(7, 8, 12) and in males.(14, 15) This gender difference has not, however, been a consistent finding.(7, 8) Our data shows higher rates of scanning at general compared to paediatric specific EDs consistent with other's findings(7, 12)

Our data indicate that overseas CDRs will need to be used with some caution in the Australasian setting. Baseline scanning rates from the two key North American CDRs(1, 15) are much higher and from the key UK rule (14) is lower than the overall

rate in our study. The implications from applying these studies in the Australasian setting are therefore unknown, and are being investigated in a prospective trial.(18)

Australian data for 2012-13 for public hospitals able to provide data to the Australian Commission on Safety and Quality in Health Care, and from Medicare billing data from non-hospital CT scans has been published. Hospital data on 13,449 scans shows emergency physicians are the key requestors of scans, that head CT is the most common scan requested. Medicare data on over 615,000 CT scans from 2004 – 2014 are reported. There was a steady CT rate for all indications from 2004 to 2009 (7.5-8 scans per 1000 children). This has declined to 6 per 1000 children by 2014 (with a large increase in MRI usage after 2011). This data does not report scans by region or indication. It is unlikely there has been a significant reduction in CT brain for head injury as MRI is time consuming, resource intensive, and rarely available in the short time frames needed in head injury. (19)

No other sources of data on rates of CT scanning for head injury have been found post 2010.

Limitations

This study has some limitations. Due to updates or changes in databases data from all sites were not available over the whole study period. Differences in CT scanning practice between participating EDs may be due to differences in the severity of head injuries seen at the different departments and differences in coding practices. The retrospective nature of this study does not allow assessment of these differences.

Our data were limited to children under 16 as this is the age range of the majority of paediatric hospitals in Australia, and ensures rates between sites do not differ on age of presentations.

The ED departure data codes used to extract head injured patients from the ED would not have identified all patients with head injury, so the incidence of CT use may not be 100 percent accurate. However these patient losses are expected to be small and are more likely with minor injuries (which are less likely to be scanned) than major trauma – making our projected CT rate higher than it may be. Also there has been no major change in coding of ED departures over the years specified so the rates across years should be comparable.

This study does not record severity of injury or appropriateness of CT scanning so cannot comment on the reasons for differences between sites, differences between previous international reports, or missed injuries associated with the observed CT scan rates.

No data are available post 2010 to describe current CT usage rates.

Conclusion

In contrast to North American reports scanning rates in our Australian population have not increased over the last decade. The rate of CTB scanning in children with head injury in this multicentre study in Australia differs from the baseline CT rates in North America and the UK. Overseas clinical decision rules will need to be used with caution in the Australasian population until local validation studies can be performed.

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