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EMA – Short report

Title:
Factors Predictive for Computed Tomography Use and Abnormality in Paediatric Head Injuries in Australia and New Zealand

Short Title

Factors Predictive for CT in Child Head Injuries

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Conflict of Interest

No authors report conflicts of interest.

Ethics Approval Statement

The study underwent central ethics review at the Royal Children's Hospital (HREC/17/RCHM/91) and institutional review at participating sites.

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Abstract:

Objectives:

To investigate patient-level factors predictive for CT brain (CTB) use and abnormality, in head injured children in Australia and New Zealand.

Methods:

Retrospective data from tertiary, urban/suburban and regional/rural EDs including factors predictive for CTB use and abnormality.

Results:

Of 3072 children at 31 EDs, 212 (6.9%) had a CTB scan, of which 66 (31%) were abnormal. Increasing age, serious mechanisms of injury and decreasing GCS were predictive for ordering CTB. Decreasing age was predictive for CTB abnormalities. Other factors weren't.

Conclusions:

Patient-level drivers of CTB use in children in Australia and New Zealand are consistent with international data.

Key words

paediatric; head injury; brain injury; computed tomography; emergency medicine

Short Report:

Introduction

At mainly tertiary paediatric emergency departments (EDs) across Australia and New Zealand (1), the rate of computed tomography of the brain (CTB) of 10.5% is lower than previously reported in North America (2-4). However, most children with head injuries present to mixed, non-tertiary EDs, where a variation in CTB rates has been reported in North America (2-4). In a study including all types of EDs in Australia and New Zealand, hospital type was not associated with CTB use rates (5). Here we set out to determine patient level factors associated with ordering a CTB and having an abnormal CTB.

Methods

This was a planned secondary analysis of a multicentre retrospective study of paediatric head injury presentations to 31 EDs in 2016 (5). EDs were stratified to tertiary, urban/suburban and regional/rural hospital types.

We included children aged <16 years, with a primary ED diagnosis of head injury. Return visits and those with prior neuroimaging at a referring hospital were excluded. Data was extracted on 100 sequential eligible cases per site (or as many as occurred) in 2016 using a standardised report form. We recorded age, gender, CTBs performed, mechanisms of injury and relevant underlying complex diagnoses (bleeding disorders, ventriculo-peritoneal shunts, neuro-developmental disability).

Demographic data were descriptively analysed comparing proportions, means and standard deviations (SDs) or medians and IQRs (for skewed distributions) using Stata v15.1 (College Station, TX, USA). Predictors of CTB scan ordering, and abnormal CTB within those ordered, were explored. Odds of demographic (age, sex) and injury mechanisms, predicting use of CTB and abnormal CTB were calculated. Univariate logistic regression explored odds

ratios (OR) of ordering CTB and abnormal CTB for each predictor, presented with 95% confidence intervals (95%CI).

Results/Findings

Of 3,572 records reviewed, 3,072 were eligible from 9 tertiary (n=900), 11 urban/suburban (n=1,072) and 11 regional/rural EDs (n=1100). Patient characteristics are shown in **Table 1**. Nine hundred and eighty-six (32.1%) were children <2 years and 41 (1.3%) had a GCS ≤13. Overall, 85 (2.8%) had relevant underlying complex diagnoses and the most common mechanism of injury was from a low fall (46.6%).

Two hundred and twelve children (6.9%) underwent CTB scan, of which 66 (31% or 2.1% overall) were abnormal. Odds of predictive factors for ordering a CTB scan or having an abnormal CTB result are presented using logistic regression analyses (**Table 2)**. Factors associated with increased odds of ordering a CTB for head injury were: increasing child age (OR 1.11, 95%CI 1.08-1.14, p<0.001); mechanisms of injury including high falls (OR 2.28, 95%CI 1.57-3.32, p<0.001), sport (OR 1.98, 95% CI 1.14-3.45, p=0.016), cycling (OR 3.82, 95%CI 2.09-6.99, p<0.001), motor vehicle accidents (OR 4.99, 95%CI 2.53-9.82, p<0.001) horse related accidents (OR 9.26, 95%CI 3.13-27.41, p<0.001) GCS of 14 (OR 11.92, 95%CI 7.54-18.85, p<0.001) and GCS $\leq$ 13 (OR 37.86, 95%CI 19.43-73.79, p<0.001). Type of hospital, did not drive differences in CTB rates.

Increasing child age was associated with less likelihood of an abnormal CTB (OR 0.92, 95%CI 0.87-0.98, p=0.008); other factors predictive of CTB use showed no association with abnormal CTBs.

Discussion

This study investigated patient related factors associated with CTB use and CTB abnormality in paediatric head injuries across a large number of diverse EDs in Australia and New Zealand with an overall low rate of CTB of 7% and CTB abnormality of 2.1%. Our results indicate that increasing child age, certain mechanisms of injury (high falls, cycling, MVAs, sport and horse related accidents), and decreasing GCS, all increased the likelihood of clinicians ordering a CTB on a child with a head injury, consistent with tertiary centre data, both locally and internationally (1-4). Conversely, decreasing child age was a predictive factor for abnormal CTB. Clinicians may have a higher threshold to conduct a CTB in younger children driven by concerns about radiation and the need for sedation. As in our previous study (5), type of hospital did not drive differences in CTB rates.

While the overall patient numbers were large and the percentage of abnormal CTBs relatively high, the CTB scanning rate across centres was low and the number of abnormal scans was low which limits deeper analysis. A further limitation lies in the use of retrospective data, though we did attempt to collect high quality data (piloting, standardised data collection and education, quality audits).

Conclusion

Factors associated with CTB use in children across a diverse range of EDs have been described and will inform the implementation of a bi-national head injury guideline for children for Australia and New Zealand.

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Table 1. Patient Cohort Characteristics

	Total N=3072	
Age (years)		
Mean (SD)	5.3	(4.6)
Median (IQR)	3.6	(1.5-8.7)
<2 years, n (%)	986	(32.1)
Gender (male), n (%)	1911	(62.2)
Glasgow Coma Score, n (%)		
15	2909	(94.7)
14	90	(2.9)
13	16	(0.5)
9-12	19	(0.6)
3-8	6	(0.2)
Missing	32	(1.0)
Relevant underlying complex diagnoses**, n (%)	85	(2.8)
Injury mechanism, n (%)		
Fall – low (<1m or <5 stairs)	1432	(46.6)
Impact injury	619	(20.1)
Fall - high/unknown (>1m or >5 stairs)	526	(17.1)
Sport	192	(6.3)
Cycling	95	(3.1)
MVA	61	(2.0)
Horse-related	16	(0.5)
Other	129	(4.2)
Missing	2	(0.1)
CTB undertaken in ED, n (%)		
CTB	212	(6.9)
CTB abnormal*	66	(31.1)
Hospital type, n (%)		
Tertiary	900	(29.3)
Urban/Suburban	1072	(34.9)
Regional/Rural	1100	(35.8)

SD=standard deviation, IQR=interquartile range

* CTB abnormal % is a subgroup of CTB

** Bleeding disorders, ventriculo-peritoneal shunts, neuro-developmental disability

Table 2: Predictive factors relating to CT use and outcomes

	Ordering CT Scan (N=3072)			Abnormal CT Scan (N=212)		
OUTCOME:	OR	(95%CI)	p	OR	(95%CI)	p
Increase by 1 yr	(ref)			(ref)		
Age (years)	1.11	(1.08-1.14)	**<0.001**	0.92	(0.87-0.98)	**0.008**
Female	(ref)			(ref)		
Male	1.22	(0.91-1.64)	0.181	0.57	(0.31-1.04)	0.065
Mechanism of Injury						
Fall - low	(ref)			(ref)		
Impact injury	0.89	(0.56-1.42)	0.633	1.04	(0.39-2.79)	0.931
Fall - high/unknown	2.28	(1.57-3.32)	**<0.001**	1.42	(0.66-3.05)	0.364
Sport	1.98	(1.14-3.45)	**0.016**	0.31	(0.07-1.50)	0.146
Cycling	3.82	(2.09-6.99)	**<0.001**	0.59	(0.15-2.31)	0.446
MVA	4.99	(2.53-9.82)	**<0.001**	2.35	(0.68-8.18)	0.179
Horse-related	9.26	(3.13-27.41)	**<0.001**	0.59	(0.06-5.59)	0.644
Other/Missing	3.04	(1.73-5.35)	**<0.001**	1.28	(0.42-3.94)	0.665
Initial GCS						
15	(ref)			(ref)		
14	11.92	(7.54-18.85)	**<0.001**	0.70	(0.29-1.67)	0.424
≤13	37.86	(19.43-73.79)	**<0.001**	1.14	(0.47-2.74)	0.770
Unknown	8.92	(4.15-19.20)	**<0.001**	3.42	(0.92-12.73)	0.067
Hospital Type						
Tertiary	(ref)			(ref)		
Suburban	0.79	(0.56-1.11)	0.176	0.53	(0.26-1.07)	0.077
Regional/rural	0.72	(0.51-1.02)	0.065	0.61	(0.30-1.25)	0.177

OR = odds ratio, CI = confidence interval, CT = computed tomography, GCS = Glasgow Coma Scale, MVA = motor vehicle accident