**The Effect of Patient Observation on Cranial Computed Tomography Rates in Children with Minor Head Trauma: the Australasian Pediatric Head Injury Rules Study (APHIRST)**

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***Meetings***: Presented in part at the Pediatric Academic Societies meeting, April 2019, Baltimore, MD; Society for Academic Emergency Medicine, May 2019, Las Vegas, NV; 18th International Conference on Emergency Medicine, June 2019, Seoul, Korea

***Funding and support:*** The study was funded by grants from the National Health and Medical Research Council (project grant GNT1046727, Centre of Research Excellence for Pediatric Emergency Medicine GNT1058560), Canberra, Australia; the Murdoch Children’s Research Institute, Melbourne, Australia; the Emergency Medicine Foundation (EMPJ-11162), Brisbane, Australia; Perpetual Philanthropic Services (2012/1140), Australia; Auckland Medical Research Foundation (No. 3112011) and the A + Trust (Auckland District Health Board), Auckland, New Zealand; WA Health Targeted Research Funds 2013, Perth, Australia; the Townsville Hospital and Health Service Private Practice Research and Education Trust Fund, Townsville, Australia; and supported by the Victorian Government’s Infrastructure Support Program, Melbourne, Australia. SS is supported by an Australian Government Research Training Program scholarship, a PREDICT CRE Research Higher Degree scholarship. FEB’s time was part funded by a grant from the Royal Children’s Hospital Foundation and the Melbourne Campus Clinician Scientist Fellowship, Melbourne, Australia and an NHMRC Practitioner Fellowship, Canberra, Australia. SRD’s time was part funded by the Health Research Council of New Zealand (HRC13/556).

**Clinical Trial Registration**: Australian New Zealand Clinical Trials Registry (ANZCTR) ACTRN12614000463673

**Declaration of conflicts of interests:** None of the authors have conflicts of interests.

**Financial Disclosure:** The authors have no financial relationships relevant to this article to disclose.

***Author contributions:*** SS conceived the study, interpreted the data and wrote the initial draft of the article. All authors designed the study, approved publication, and agreed to be accountable for all aspects of the work. MLB, SRD, JN, JAC, AK, YG, NP, AW, MDL, SB, EO, and FEB obtained the data. SJCH and SD supervised the analysis of the data, contributed to the interpretation of the data, and revised the article critically. MLB, SRD, JN, JAC, AK, YG, NP, AW, MDL, SB, EO, JFH, NK, and FEB interpreted the data, provided supervision, and drafted or revised the paper critically. SS takes responsibility for the paper as a whole.

All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

***Acknowledgements:*** We thank the participating families and emergency department staff at participating sites. We thank Sarah Dalton and Mary McCaskill (The Children’s Hospital at Westmead, Sydney); Jeremy Furyk (The Townsville Hospital, Townsville); and Louise Crowe (Murdoch Children’s Research Institute, Melbourne) for their involvement with obtaining the data and prior data analysis. We thank Daniel Tancredi, Ph.D. (Departments of Pediatrics and Emergency Medicine at the University of California Davis School of Medicine, Sacramento, CA, USA) for his review of the statistical analysis; and Maya Singh (Brown University, Providence, RI, USA) for critical review of the manuscript.

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**ABSTRACT**

**Objective:**

Management of children with minor blunt head trauma often includes a period of observation to determine the need for cranial computed tomography (CT). We explored the relationship between planned observation and cranial CT use.

**Methods:**

This was a planned sub-analysis of a prospective observational study at 10 pediatric emergency departments in Australia and New Zealand, of children <18 years, presenting within 24 hours of blunt head trauma, with Glasgow Coma Scale scores 14-15. After the initial patient assessment, clinicians documented if they planned to observe, and if they planned to obtain cranial CT. Clinically important traumatic brain injury (ciTBI) was defined as death due to head trauma, neurosurgery, intubation for > 24 hours for head trauma, or hospitalization for 2 or more nights in association with a positive cranial CT scan. We estimated the adjusted odds of cranial CT use with planned observation using a generalized linear model with mixed effects.

**Results:**

The cranial CT rate in the total cohort (18,471 patients) was 8.6%, and 0.8% had ciTBI. The cranial CT rate was lower in those with planned observation (4.2%) than those in the no planned observation cohort (10.1%), (rate difference 5.7%, [95% CI: 5.0 – 6.5%]), as was the ciTBI rate (0.4% vs. 0.9%; rate difference 0.5%, [95%CI: 0.3-0.8%]). After adjusting for time from injury, patient characteristics, history of seizure, ciTBI risk, and hospital clustering, the patients with planned observation had significantly lower cranial CT rates (adjusted odds ratio 0.2, [95% CI: 0.15-0.21]).

**Conclusions:**

Even in a setting with low overall cranial CT rates in children with minor blunt head trauma, planned observation was associated with decreased cranial CT use.

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**INTRODUCTION**

**Background**

Minor head trauma in children is a common emergency department (ED) presentation and is commonly defined by a Glasgow Coma Scale (GCS) score of 14-15 following head trauma.1,2 Cranial computed tomography (CT) to diagnose traumatic brain injury (TBI) after trauma is the current gold standard investigation, however the ionizing radiation exposure is associated with an increased risk of lethal malignancies.3-6 There has been concern about increasing CT rates in children presenting to EDs in the United States from 1998 to 2008.7 Retrospective studies on cranial CT trends in pediatric EDs have noted considerably higher rates in the U.S. (27.6% in 2007 to 30.2% in 2015)8 as compared with Australia (9.5% in 2001 to 9.6% in 2010).9 This difference has been confirmed with prospective studies reporting lower non risk-adjusted cranial CT rates in Australia (8.3%) compared to the U.S. (35.3%), with similar rates of clinically important traumatic brain injuries.1,10 Clinical decision rules have been developed and validated, to aid clinical decision-making, improve the sensitivity of identifying patients with TBI and optimize cranial CT rates.1,10-13

**Importance**

With the Choosing Wisely campaign, the American Academy of Pediatrics and the American College of Emergency Physicians have endorsed the benefit of an observation period for the management of pediatric head injury.14,15 Observation reduces cranial CT scan rates for children with minor blunt head trauma, with no significant impact on the delayed diagnosis of ciTBI.16,17 One investigation reported that observation was associated with a nearly 50% reduction in cranial CT use when compared with those not observed.16 In a subsequent study, every hour increase in ED observation was associated with decreased cranial CT rates across all 3 groups of patients at risk for ciTBI in the clinical decision rule derived by the Pediatric Emergency Care Applied Research Network (PECARN): very low risk (adjusted OR 0.47), intermediate risk (adjusted OR 0.28), and high risk (adjusted OR 0.11).17

**Goal of this investigation**

We explored the relationship between planned ED observation and cranial CT use in children with minor blunt head trauma in a clinical setting with low baseline cranial CT rates (i.e. Australia/New Zealand). Additionally, we evaluated the effect of ED observation on cranial CT rates in children for the different PECARN-defined TBI risk groups.1

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**METHODS**

**Study Design and Setting**

This was a planned secondary analysis of a prospective, cohort study of children younger than 18 years of age with minor blunt head trauma, enrolled between April 2011 and November 2014 in 10 pediatric EDs in Australia and New Zealand for the Pediatric Research in Emergency Departments International Collaborative (PREDICT) network.18 The individual hospital ethics committee for each participating site approved the study. The details of the study protocol have been previously published.19

**Selection of Participants**

The treating clinicians enrolled patients presenting to the ED with blunt head trauma. A standardized case report form was completed recording demographic, epidemiologic and clinical information. After the initial assessment, clinicians documented responses to two questions that were not mutually exclusive: if they planned to observe the patient (“Do you intend to observe the patient in ED for head injury? yes/no”), and if they planned to obtain immediate neuroimaging (“Do you intend to perform neuroimaging for this patient? yes/no”). Based on the responses, the planned observation cohort included those with planned observation and no immediate plan for cranial CT. The no planned observation cohort included those with either planned immediate cranial CT and/or no planned observation. All site investigators, participating ED clinicians and research assistants received formal training before and during the study and were not blinded to the purpose of the study.

Inclusion criteria: all children younger than 18 years of age presenting to the ED after sustaining blunt head trauma of any severity were enrolled in the original study.10 For this sub-analysis, we selected the cohort of children with GCS scores of 14-15 presenting within 24 hours of head trauma, to enable direct comparison with prior published results. Children with multiple ED visits, with different episodes of head trauma, were eligible for enrolment at each visit.

Exclusion criteria: patients with trivial facial trauma, if they presented to the ED with neuroimaging for head trauma prior to study enrolment, and those with history of blunt head trauma who left the ED without being seen by a physician.

**Measurements**

Physicians recorded ED data; research assistants recorded the data regarding hospital management, and conducted telephone follow-up on patients who did not have neuroimaging. Results of cranial CTs performed on patients who re-presented to the ED were reviewed. Neuroimaging and neurosurgery reports were reviewed for any patients identified on follow-up telephone call to have had medical visits outside the original study hospital.

Timing of events were calculated using information collected on case report forms including time from injury to ED arrival, time from ED arrival to physician evaluation, ED length of stay (LOS), and total LOS. We defined ED LOS as the interval of time from ED arrival until ED discharge. Total LOS was defined as time from ED arrival to hospital discharge. Data on admission rates included those admitted to short stay units for observation, hospital wards or pediatric intensive care units (PICU). The short stay unit admitted patients with anticipated LOS <24 hours. The location of the short stay units varied across the participating hospitals (part of ED, separate unit in ED, or a ward). As a result, for those patients admitted to observation units, but not inpatient wards or PICU, the ED LOS was the interval of time from ED arrival until hospital discharge.

We stratified the population at risk for ciTBI using the age-based PECARN ciTBI risk groups: very low, intermediate, and high (Table 1).1 Children with no predictors for ciTBI were classified as very low risk. Children with 1 or more risk factors were classified as intermediate or high risk, depending on the specific risk factor, according to the original PECARN paper.1

**Outcomes**

The primary outcome measures were cranial CT and ciTBI rates. Secondary outcome measures were ED and hospital LOS, rates of TBI on cranial CT and hospital admission. The ED clinician’s initial assessment of the patient’s GCS score, attending radiologist reports of the CT scans, and operative reports of neurosurgical interventions were used for each site.

The outcome, cranial CT, was defined as present if the patient underwent the imaging study during ED or short stay evaluation. The outcome, ciTBI, was defined as: death as a result of intracranial injury, neurosurgical intervention, intubation for longer than 24 hours for TBI or hospital admission for 2 nights or longer in association with TBI on cranial CT.1 Neurosurgical intervention for TBI included intracranial pressure monitoring, elevation of depressed skull fracture, ventriculostomy, hematoma evacuation, lobectomy, tissue debridement, dura repair, and other procedures.1

TBI on cranial CT was defined as: intracranial hemorrhage or contusion, cerebral edema, traumatic infarction, diffuse axonal injury, shearing injury, sigmoid sinus thrombosis, midline shift of intracranial contents or signs of brain herniation, diastasis of the skill, pneumocephalus, and skull fracture depressed by at least the width of the table of the skull.1

**Analysis**

We described two cohorts of children, those with a planned observation and those with no planned observation, with population proportions and 95% confidence intervals (CI). Additionally, we compared the proportion of patients with signs and symptoms of head injury and the resulting PECARN ciTBI risk groups between the two cohorts. We performed a bivariate analysis of rates of CT scans, ciTBI and TBI on CT, and hospital admission rates between the 2 cohorts.

We compared time in hours as categorical variable using medians with inter–quartile ranges, and rate differences using the Hodges-Lehmann method, which accounts for different population distributions in the two cohorts. The total LOS (hours) was compared, as well as ED LOS, LOS for each PECARN TBI risk group, and LOS in patients who had cranial CT scans.

We investigated the relationship between observation status and cranial CT scan rates. Using a generalized linear model with mixed effects, we estimated cranial CT use with multivariable logistic regression adjusting for patient demographics, history of seizure, PECARN TBI risk group, time from injury and ED LOS. Because planned observation and cranial CT rates could be correlated with clinician practice within a hospital site, we controlled for hospital cluster as a random effect (with random intercept). Further, because clinician practice could vary across the study time period (2011 – 2014), we adjusted for calendar year as a fixed effect, with 2011 as a reference.

Sample size calculations were performed and published in the primary study,10,19 and no additional computations were performed for this planned sub analysis. Data were entered in Epidata (The Epidata Association, Odense, Denmark) initially, and later REDCap.20 Data analysis was performed with Stata (version 13; StataCorp, College Station, TX) for the analysis.

**RESULTS**

**Characteristics of study subjects**

Of the 20,137 enrolled patients in the original study,21 18,781 (93.3%) presented within 24 hours of sustaining head trauma, with GCS scores of 14-15. Documented planned observation and cranial CT status was available for 18,471 (91.7%) of enrolled patients, and all subsequent analyses were performed on this cohort (Figure).

In the analytic cohort, the mean age was 5.7 years, 4,959 (26.9%) were <2 years of age, 11,773 (63.8%) were boys, 3,429 (18.6%) had severe mechanisms of injury, 3,369 (18.3%) had a non-frontal scalp hematomas, 3,006 (16.4%) had histories of vomiting, 2,399 (13.6%) had histories of loss of consciousness, 1522 (8.2%) had altered mental status, and 553 (3.0%) presented with GCS scores of 14. Stratified by the PECARN TBI risk groups: 9,867 (53.4%) were very low risk, 7,027 (38.0%) were intermediate risk, and 1,577 (8.5%) were high risk for ciTBI.

The strategy of planned observation was made for 4,945 (26.8%) patients, with a range of 21% to 49% across the participating hospitals (Table 2). Those in the planned observation group were slightly older and more likely to have symptoms and signs of TBI. The median time from injury to ED arrival in the cohort with planned observation was not statistically different than those with no observation (Table 3). The median ED LOS in the cohort with planned observation was significantly longer than those not observed. Similarly, the ED LOS was significantly higher for each of the PECARN TBI risk groups in the planned observation cohort.

Admission for observation was included in the total hospital admission rate and was not mutually exclusive (patients could be admitted to both short stay and the inpatient ward). The distribution of the 4,049 (21.9%) patients in the analytic cohort who were admitted included: short stay unit (2,990, 74.2%), inpatient ward (1063, 26.4%), and PICU (49, 1.2%). There was a significant difference in the admission rates for patients with planned observation compared to those not observed, both for inpatient ward and PICU admissions (Table 4).

There were no deaths reported in either cohort (Table 4). There was no difference in missed ciTBI between the cohorts, with one patient in both groups, at intermediate risk for ciTBI.

**Main results: Cranial CT rates and observation**

The average cranial CT rate was 8.6% (range 2-16% across the different hospitals), with ciTBI rate of 0.8% and 0.1% of patients receiving neurosurgical intervention. Cranial CT rates for each of the PECARN TBI risk categories varied significantly: very low risk (1.8%), intermediate risk (10.3%) and high risk (43.1%). Similarly, the ciTBI rates varied significantly, with 0.01% in the PECARN very low risk group, 0.6% in the intermediate risk and 6.3% in the high-risk group.

The cranial CT rate was lower in those with planned observation (4.3%) compared with the immediate cranial CT (10.1%) or no planned observation cohort (Table 3). After adjusting for PECARN TBI risk group, patient, and hospital characteristics, the cohort with planned observation had significantly lower cranial CT use (adjusted OR 0.2, [95% CI: 0.2-0.2). A sensitivity analysis of the generalized linear model, adjusting for individual signs and symptoms of TBI instead of PECARN TBI risk groups produced similar results (adjusted OR 0.2, [95% CI: 0.1-0.2]).

**LIMITATIONS**

There are several limitations with our study. First, the questions asked of the clinicians on the case report forms regarding planned observation and planned immediate cranial CT were not mutually exclusive. Additionally, the questions did not clarify the reasons for planned observation in the 986 (5.3%) patients who also had planned immediate cranial CT. There was no difference in the cranial CT rates in these patients (95.3%) and those with planned immediate cranial CT and no planned observation (95.4%). All patients with planned immediate cranial CT, whether or not planned observation was also indicated, were included in the no planned observation cohort. As a result, we believe the effect of observation on the cranial CT rate is accurately reflected in the comparison cohort with planned observation *and* no plan for immediate cranial CT.

Second, there were significant differences between the patients with a planned observation and those without planned observation. The patients who received an immediate cranial CT and were not observed were more symptomatic, with more frequent severe mechanisms of injury, at a higher risk for ciTBI, and had higher ciTBI and TBI on cranial CT rates. Although we used multivariable logistic regression to adjust for the impact of these factors on cranial CT use, there could be some unaccounted for confounding or bias. However, this should have a minimal effect on our analysis.

Third, we did not collect data on the time from physician evaluation to the time of the cranial CT order. Therefore, we cannot measure the incremental effect of observation time on cranial CT use. Finally, because we did not have time stamps regarding the time of completion of case report forms, it is not clear if the decision for neuroimaging was made because of progression of symptoms or other factors not recorded at the time the case report form was completed. As the data collected were static, we do not know if the data accurately represent the dynamic nature of evolution of disease and clinicians’ decision-making.

**DISCUSSION**

This multicenter prospective study evaluated the strategy of planned ED observation and cranial CT use in children with minor head trauma. Despite the low baseline cranial CT rate, planned observation was associated with 80% lower adjusted odds of cranial CT use. The cohorts with and without planned observation were dissimilar in individual patient characteristics and risks for ciTBI; however, after adjusting for patient, hospital and risk factors, planned observation was independently associated with lower cranial CT use. Our results suggest that planned observation is an appropriate strategy for many patients not at low risk for ciTBI based on the PECARN TBI risk groups, with decreased resulting CT rates and no significant difference in the missed ciTBI rate.

The results of this study validate the published literature from North America, where ED observation is associated with lower cranial CT rates.16,17,22,23 Prior research on the cranial CT rates of each of the PECARN TBI risk predictors in the US was reported as 13% of low risk, 54% of intermediate and 82.5% of high-risk groups.24 Published evidence of the clinical practice in Australia and New Zealand for pediatric minor head trauma termed as “usual care” report lower cranial CT rates when compared with the use of decision rules.9,21 We report much lower CT rates for each of the PECARN TBI risk groups (1.8% of very low risk, 10.3% of intermediate and 43.1% of high risk) that reflect differences in clinical practice.

The increase in lifetime attributable risk of cancer associated with ionizing radiation of cranial CT scans has been reported worldwide.4-6 The cumulative radiation in children might triple the risk of leukemia and brain tumors, a large retrospective study reports.6 With increasing awareness of these risks, it has become important to educate health care providers and parents as a shared decision making process. Implementation of clinical decision tools has resulted in decreased cranial CT rates for mild head trauma at pediatric and general emergency departments.22,25-27 However, this has not been the case at the national level in the US, with no apparent decrease in cranial CT rates in children between 2007 and 2015.8

The PECARN clinical decision rules identify those patients at very low risk for ciTBI, and for whom cranial CT is usually not recommended.1 Incorporating decision support in the electronic medical record based on the PECARN rules reduces cranial CT rates in the ED for children at very low risk for ciTBI.27 The average cranial CT rates across all the intervention EDs decreased from 5.3% to 4.2%. Further, Dayan et al. report that it is possible to achieve benchmark cranial CT rates of <5% in children with mild blunt head trauma at very low risk for ciTBI.27 We report a cranial CT rate of 1.8% in the patients at very low risk for ciTBI, with no significant difference in cranial CT rates, ciTBI or TBI between those with or without planned observation. This supports the recommendation that there is no benefit in observing patients at very low risk for ciTBI, and therefore limiting low value cranial CT scans by “choosing wisely”.

Using a decision support tool for shared decision-making with parents of children at intermediate risk for ciTBI from mild blunt head trauma, researchers reported no difference in cranial CT rates when compared with usual care (22% vs. 24%).28 However, they report a significant difference in average imaging rate and healthcare utilization 7 days after injury between the 2 groups. We report a significant difference in cranial CT rates with planned observation, in children at intermediate risk for ciTBI. This emphasizes the role of shared decision-making and observation as a strategy in children at intermediate risk for ciTBI and more research is required to understand the health economic aspects of these strategies.

In summary, planned observation, as a strategy for the management of minor head trauma is associated with lower cranial CT use in a setting with low baseline CT rates. Targeted planned observation in those not at low risk for ciTBI has the potential to safely reduce the rate of CT scanning overall by optimizing the selection of patients more likely to have ciTBIs.

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ED, Emergency department; GCS, Glasgow Coma Scale; CT, Computed tomography; ciTBI, Clinically important traumatic brain injury

Figure. Patient flow diagram

**Table 1.** Children with minor head trauma (GCS≥14): PECARN TBI risk groups.

|  |  |  |
| --- | --- | --- |
| PECARN TBI Risk Group | Children Age <2years | Children Age ≥2 years |
|
| High | Altered mental status\* | Altered mental status\* |
|  | Palpable skull fracture | Signs of basilar skull fracture§ |
| Intermediate | Severe injury mechanism¶ | Severe injury mechanism¶ |
|  | History of loss of consciousness ≥5secs | History of any loss of consciousness |
|  | Nonfrontal hematoma | History of vomiting |
|  | Not acting normally per parents | Severe headache in the ED |
| Very Low | None | None |
| GCS, Glasgow Coma Scale; PECARN, Pediatric Emergency Care Applied Research Network; TBI, Traumatic brain injury. |
| \* GCS =14, agitation, sleepiness, slow response, or repetitive questioning. |
| § Post-auricular bruising (battle sign), periorbital bruising (raccoon eyes), cerebrospinal fluid otorrhea or hemotympanum. |
| ¶ Motor vehicle crash with patient ejection, death of another passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; falls of higher that 3 feet for children younger than 2 years of age and higher than 5 feet for children older than 2 years of age; or head struck by a high-impact object. |
|
|

**Table 2.** Patient demographics

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Planned Observation** n (%) | **No Planned Observation**n (%) | **Rate Difference**% (95% CI) |
|  | 4,945 | (26.8) | 13,526 | (73.2) |  |
| **Demographic characteristics** |  |  |  |  |  |  |
| Age (years) |   |   |   |   |   |   |
| Mean (SD) | 6.2 | (5.1) | 5.5 | (4.4) | 0.7 | (0.6 - 0.9) |
| Median (IQR) | 4.5 | (1.8 - 10.7) | 4.0 | (1.9 - 8.1) | 0.3 | (0.2 - 0.4) |
| Age <2 years | 1,393 | (28.2) | 3,566 | (26.4) | 1.8 | (0.4 - 3.3) |
| Sex [male] | 3,102 | (62.7) | 8,671 | (64.1) | -1.4 | (-3.0 to 0.2) |
| Glasgow Coma Scale score |  |  |  |  |  |  |
| 15 | 4,778 | (96.6) | 13,140 | (97.2) | -0.5 | (-1.1 to 0.1) |
| 14 | 167 | (3.4) | 386 | (2.9) | 0.5 | (-0.1 to 1.1) |
| **Symptoms and signs** |  |  |  |  |  |  |
| History of vomiting | 1,357 | (27.6) | 1,649 | (12.3) | 15.3 | (13.9 - 16.7) |
| Altered mental statusa | 583 | (11.8) | 939 | (6.9) | 4.9 | (3.9 - 5.8) |
| Severe injury mechanismb | 1,207 | (24.4) | 2,222 | (16.4) | 8.0 | (6.6 - 9.3) |
| History of loss of consciousness [Known or suspected] | 1,145 | (24.9) | 1,254 | (9.6) | 15.2 | (13.9 - 16.6) |
| History of seizure | 146 | (3.0) | 125 | (0.9) | 2.1 | (1.6 - 2.6) |
| Clinical evidence of skull fracturec | 37 | (0.8) | 271 | (2.0) | -1.3 | (-1.6 to -0.9) |
| Non-frontal scalp hematoma | 968 | (19.6) | 2,401 | (17.8) | 1.8 | (0.5 - 3.1) |

a GCS =14, agitation, sleepiness, slow response, or repetitive questioning

b Motor vehicle crash with patient ejection, death of another passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; falls of higher that 3 feet for children younger than 2 years of age and higher than 5 feet for children older than 2 years of age; or head struck by a high-impact object

c Probable or possible skull fracture based on swelling or distortion of the scalp on digital examination or signs of a basilar skull fracture

**Table 3**. Median intervals: planned observation vs. no planned observation

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Planned observation** | **No planned observation** | **Time Difference** |
| **Interval [hours]** | n | Median | (IQR) | n | Median | (IQR) | Median | 95% CI |
| Injury to ED arrival | 4,892 | 1.3 | (0.8 - 2.2) | 13,293 | 1.3 | (0.8 - 2.9) | -0.1 | (-0.1 to -0.1) |
| ED arrival to physician evaluation | 4,936 | 0.4 | (0.2 - 0.7) | 13,502 | 0.5 | (0.2 - 1.0) | -0.1 | (-0.2 to -0.1) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **ED length of stay (LOS) [hours]** |  |  |  |  |  |  |  |  |  |  |  |
| Overall | 4,935 | 3.7 | (2.7 - 5.2) | 13,495 | 1.9 | (1.2 - 3.1) | 1.7 | (1.6-1.7) |
| PECARN TBI Risk Group |  |  |  |  |  |  |  |  |  |  |  |
| Very low-risk | 1,639 | 3.4 | (2.4 - 4.6) | 8,211 | 1.7 | (1.1 - 2.6) | 1.6 | (1.5-1.7) |
| Intermediate risk | 2,709 | 3.7 | (2.8 - 5.3) | 4,298 | 2.2 | (1.3 - 3.6) | 1.5 | (1.4-1.6) |
| High risk | 587 | 4.4 | (3.3 - 7.3) | 986 | 3.9 | (2.4 - 6.3) | 0.7 | (0.4-0.9) |
| Cranial CT |  |  |  |  |  |  |  |  |  |  |  |
| Obtained | 213 | 6.0 | (4.0 - 13.0) | 1,359 | 4.9 | (3.5 - 7.5) | 1.2 | (0.6-1.9) |
| Not obtained | 4,722 | 3.6 | (2.7 - 5.1) | 12,136 | 1.7 | (1.1 - 2.7) | 1.8 | (1.8-1.9) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Total LOS [hours]** |  |  |  |  |  |  |  |  |  |  |  |
| Overall | 4,934 | 3.7 | (2.7 - 5.5) | 13,484 | 1.9 | (1.2 - 3.3) | 1.7 | (1.6-1.8) |
| PECARN TBI Risk Group |  |  |  |  |  |  |  |  |  |  |  |
| Very low-risk | 1,639 | 3.4 | (2.5 - 4.7) | 8,209 | 1.7 | (1.1 - 2.6) | 1.7 | (1.6-1.7 |
| Intermediate risk | 2,708 | 3.8 | (2.8 - 5.6) | 4,296 | 2.3 | (1.3 - 3.8) | 1.5 | (1.4-1.5) |
| High risk | 587 | 4.6 | (3.4 - 9.8) | 979 | 6.6 | (2.9 - 24.3) | -1.4 | (-2.2 to -0.8) |
| Cranial CT |  |  |  |  |  |  |  |  |  |  |  |
| Obtained | 213 | 11.8 | (4.6 - 22.0) | 1,350 | 14.3 | (4.5 - 36.3) | -0.7 | (-1.9 to 0.4) |
| Not obtained | 4,721 | 3.7 | (2.7 - 5.2) | 12,134 | 1.7 | (1.1 - 2.8) | 1.8 | (1.8-1.9) |

**Table 4**. PECARN TBI risk groups and patient outcomes

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Planned Observation** n (%) | **No Planned Observation**n (%) | **Rate Difference**% (95% CI) |
|  | 4,945 | (26.8) | 13,526 | (73.2) |   |
| **PECARN TBI risk group** |  |  |  |  |  |  |
| Very low | 1,641 | (33.2) | 8,226 | (60.8) | -27.6 | (-29.1 to -26.1) |
| Intermediate | 2,716 | (54.9) | 4,311 | (31.9) | 23.1 | (21.5 - 24.7) |
| High | 588 | (11.9) | 989 | (7.3) | 4.6 | (3.6 - 5.6) |
|  |  |  |  |  |  |  |
| **CT performed** | 215 | (4.3) | 1,364 | (10.1) | -5.7 | (-6.5 to -5.0) |
| **PECARN TBI risk group** |  |  |  |  |  |  |  |
| Very low: n (within group %) | 26 | (1.6) | 149 | (1.8) | -0.2 | (-0.9 to 0.4) |
| Intermediate: n (within group %) | 123 | (4.5) | 601 | (13.9) | -9.4 | (-10.7 to -8.1) |
| High: n (within group %) | 66 | (11.2) | 614 | (62.1) | -50.9 | (-54.8 to -46.9) |
|  |  |  |  |  |  |  |  |
| **ciTBI** | 20 | (0.4) | 126 | (0.9) | -0.5 | (-0.8 to -0.3) |
| Death from head injury | 0 | (0.0) | 0 | (0.0) | 0.0 | (0.0 – 0.0) |
| Neurosurgical intervention | 2 | (0.0) | 21 | (0.2) | -0.1 | (-0.2 to -0.0) |
| Intubation for >24 hours | 0 | (0.0) | 2 | (0.0) | 0.0 | (-0.0 to 0.0) |
| Hospital admission ≥2 nights with +CT | 20 | (0.4) | 125 | (0.9) | -0.5 | (-0.8 to -0.3) |
| **PECARN TBI risk group** |  |  |  |  |  |  |
| Very low: n (within group %) | 0 | (0.0) | 1 | (0.0) | -0.01 | (-0.04 to 0.01) |
| Intermediate: n (within group %) | 14 | (0.5) | 31 | (0.7) | -0.2 | (-0.6 to 0.2) |
| High: n (within group %) | 6 | (1.0) | 94 | (9.5) | -8.5 | (-10.5 to -6.5) |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **TBI on CT** | 32 | (0.7) | 195 | (1.4) | -0.8 | (-1.1 to -0.5) |
| **PECARN TBI risk group** |  |  |  |  |  |  |
| Very low: n (within group %) | 0 | (0.0) | 1 | (0.01) | -0.01 | (-0.04 to 0.01) |
| Intermediate: n (within group %) | 23 | (0.8) | 56 | (1.3) | -0.5 | (-0.9 to 0.0) |
| High: n (within group %) | 9 | (1.5) | 138 | (14.0) | -12.4 | (-14.8 to -10.1) |
|  |  |  |  |  |  |  |
| **Hospital Admission rate** | 2,238 | (45.3) | 1,811 | (13.4) | 31.9 | (30.4 - 33.4) |
| Short stay admission | 2,056 | (92.0) | 934 | (52.1) | 39.9 | (37.3 - 42.5) |
| Ward admission | 199 | (8.9) | 864 | (48.1) | -39.2 | (-41.8 to -36.6) |
| PICU | 3 | (0.1) | 46 | (2.6) | -2.4 | (-3.2 to -1.7) |
| **Return ED visit**d | 699 | (14.8) | 1,457 | (12.0) | 2.8 | (1.6 - 3 .9) |
| ciTBI  | 1 | (0.1) | 1 | (0.1) | 0.1 | (-0.2 to 0.4) |
| TBI on CT | 1 | (0.1) | 0 | (0.0) | 0.1 | (-0.1 to 0.4) |

ciTBI, Clinically important traumatic brain injury; TBI-CT, Traumatic brain injury on computed tomography.

d If had follow-up interview: Planned Observation n=4,723; No Planned Observation n=12,055