EVALUATIONS OF COMPUTED TOMOGRAPHY (CT) SCAN ORDERING IN CHILDREN WITH MILD HEAD INJURY AT EMERGENCY DEPARTMENT AT SUEZ CANAL UNIVERSITY HOSPITAL

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ABSTRACT

Introduction: CT is the gold standard diagnostic test for evaluating children with head trauma, however, this procedure has disadvantages, including exposure to ionizing radiation, transport of the child away from the direct supervision of emergency physicians, the frequent requirement for pharmacologic sedation, additional health care costs, and increased time for completing Emergency Department (ED) evaluation. The Pediatric Emergency Care Applied Research Network (PECARN) is a clinical decision rule that aims to determine which children are at very low risk of developing clinically significant traumatic brain injury (ci TBI) and who therefore do not require a CT scan of the head.

* (ci TBI) defined by death from TBI, need for Neurosurgery, intubation more than 24 hours for TBI, or Hospital admission more than two nights for TBI. The aim of the study: This study aimed to improve the quality of management of children with mild Traumatic Brain Injury (mTBI) at the Emergency Department (ED) by evaluating CT scan ordering in comparison to the PECARN clinical decision rule (CDR). Methodology: The present study was a cross-sectional observational study that was conducted at the Emergency Department (ED) of Suez Canal University (SCU) Hospital. It included 97 children, 18 years old or younger with a history of blunt head trauma within the last 24 hours with Glasgow Coma Score (GCS) between 13-15 who presented to ED at SCU Hospital. Results: The present study revealed that 20.6% of patients were classified as High Risk, 45.3% as Intermediate Risk, and 35% as the Low risk of developing (ci TBI) according to PECARN CDR. CT scan was ordered in all patients classified as High Risk, 90.9% of patients classified as Intermediate Risk, and 51.5% of patients classified as Low Risk. Conclusions: The present study revealed that most of the patients were adherent to PECARN CDR. Also, most of the patients younger than two years old followed the CDR. Most of the patients older than two years old followed the CDR.

KEYWORDS: PECARN, CDR

Introduction:

CT scan is the standard gold test for the evaluation of TBI as it is universally available, it has a rapid acquisition time, is easy to interpret, it has reliable results, it can identifies traumatic brain injuries rapidly and accurately, potentially reducing morbidity and mortality. [1],[2] However, it has high costs, can be difficult to obtain due to the need of transporting the child away from the direct supervision of emergency physicians, also the common
All children 18 years old or younger with a history of blunt head trauma. Patients with mild TBI (GCS: 13-15) were clinically assessed and managed by the ABC protocol. After stabilising the patient, the following were studied:

- **Mechanism of injury.**
- **Clinical presentation.**
- **Symptoms as:** agitation, vomiting, loss of consciousness, severe headache or signs as skull hematoma, signs of fracture base (roacoon eye, bleeding per ear or nose, battle’s sign).

**Exclusion criteria:**
1. Age: more than 18 years old.
2. Patients with GCS less than 13 after 30 minutes from the event.
3. Patients presented to the Emergency department after 24 hours from the event.
4. Patients are known to have a bleeding tendency or coagulopathy.
5. Patients are known to have the chronic neurologic disease (Congenital anomalies, Cerebral, Epilepsy).
6. Patients with penetrating head injury.
7. Patients are known to have a brain tumour.
8. Patients with other significant injuries that may affect the conscious level, i.e. chest injuries causing hypoxia, external bleeding or internal haemorrhage causing hypovolemia.

**Sample size:**
\[
\text{n} = \frac{Z_{\alpha/2}^2 \times Sp(1 - Sp)}{E^2} \\
= \frac{1.96^2 \times 0.058(1 - 0.058)}{0.1^2} \\
= 97.034
\]

Data were collected in a pre-organized data sheet by the researcher from patients fulfilling inclusion criteria. The patient was clinically assessed and managed by the ABC protocol. After stabilising the patient, the following were studied:

- **Socio-demographic data:**
- **Trauma data:**
  - Time of injury and time of hospital arrival.
  - Mechanism of injury.
  - Clinical presentation.
  - Symptoms as: agitation, vomiting, loss of consciousness, severe headache.
  - Signs as: skull hematoma, signs of fracture base (roacoon eye, bleeding per ear or nose, battle’s sign).
- **Associated injuries.**
- **Clinical examination:**
  - Vital signs: pulse, blood pressure, respiratory rate.
  - Initial assessment of ABCDE (airway and cervical spine control, breathing, circulation, dysfunction of central nervous system and exposure).
- **Neurological examination:**
  - A regional examination of Head and Neck, Chest, Abdomen, Extremities, and Back.
  - Assess the condition of the patients either stable or unstable which determined the needed investigations and plane of management.

- **Investigations:**
  - Laboratory investigations, as complete blood count, blood typing and crossmatch.
  - Computed tomography (CT) scan of the brain ordering and its result if CT was done.
- **Fate at Emergency Department within the first 24 hours:**
  - Neurosurgical consultation and its result.
  - Admission in the inward.
  - Admission in the ICU.
  - Discharged.

- Referred.
- Died.

**Data management & Statistical analysis**

- Socio-demographic data, mechanism of injury, duration, manifestations and need for CT scan and its result were collected and coded then entered spreadsheets using Microsoft excel for windows office 2013.
- Data analysis using Statistical Package of Social Science (SPSS) software program version 10.0 for analysis.
- Data were presented as tables and graphs; Chi-square test was used to compare the qualitative data expressed as numbers and percentages.
- P value is considered as significant when p < 0.05.

**Ethical consideration**

In this observational non-interventional study parental verbal consent and participant verbal assent (for patients deemed capable of understanding and appropriately answer questions) will be obtained for all patients; it will include permission to conduct a follow-up telephone call to determine the outcome. Patients who refuse consent or withdraw will continue to be managed as per the treating clinician.

As this is an observational study, we are not anticipating adverse events. This study was proved from committee of ethics in Suez Canal University

**Results:**

Table 1 Mechanism of injury among patients at different age groups:

<table>
<thead>
<tr>
<th></th>
<th>Patients &lt;2years old.</th>
<th>Patients&gt;2years old.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n.</td>
<td>%</td>
</tr>
<tr>
<td>RTA*</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>FFH**</td>
<td>12</td>
<td>60%</td>
</tr>
<tr>
<td>Direct Head Trauma</td>
<td>6</td>
<td>30%</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100%</td>
</tr>
</tbody>
</table>

*RTA: road traffic accident. **FFH: falling from height

The present study revealed that 62.9% of all patients were adherent to PECARN CDR, and 37.1% were not adherent to the CDR. Also, 85% of patients younger than two years old followed the CDR while 15% did not follow the CDR. Fifty-seven percentage of patients older than two years old followed the CDR while 43% did not follow the CDR. Fifty-seven percentage of patients older than two years old followed the CDR while 43% did not follow the CDR.

Silvia Bressan investigated the implementation of adapted PECARN decision rule for children with minor head injury at the Pediatric Emergency Department (an observational study conducted at the Pediatric Emergency Department of Padova children University Hospital, Italy, 2010) which revealed that adherence to the adapted PECARN rule was observed in 93.5% of studied population (330 of 353 patients).[10]

In contrast to the present study which revealed that adherence to PECARN CDR was 62.8% in all patients. Silvia Bressan was a post-implementation study that was conducted after 6 months of training of physicians which includes, dedicated teaching sessions, e-mailing of teaching material, as well as the adapted PECARN rule, posters explaining the algorithms in the Pediatric Emergency Department (PED), availability of the new protocol for the management of minor head injury for online consultation in the intranet website, and ample supply of pocket cards.[10]

Roberto Velasco investigated the Compliance with the PECARN CDR in diagnostic approach of mild head trauma in 70.5% of patients followed the PECARN CDR and in 97.2% of patients that did not follow the CDR. The present study revealed that 20.6% of patients were classified as High Risk, 45.3% as Intermediate Risk, and 35% as the Low risk of developing ci TBI according to PECARN CDR. CT scan was ordered in all patients classified as High Risk, 90.9% of patients classified as Intermediate Risk, and 51.5% of patients classified as Low Risk. The present study revealed that 63.92% of patients were discharged on instructions, 36% of patients were observed in the ED and 13.4% of patients (13 patient) met the definition of ci TBI (7 patients needed neurosurgical intervention, six patients needed inward admission, no patient died or needed ICU admission).

**Discussion:**

This was a descriptive, cross-sectional observational study that was conducted at ED at SCU Hospital for ten months (from November 2014 to August 2015) to evaluate CT scan ordering in children with MTBI aiming to improve the quality of management at the ED.

A total of 97 patients matching inclusion criteria were enrolled in this study. The present study revealed that 62.9% of all patients were adherent to PECARN CDR, and 37.1% were not adherent to the CDR. Also, 85% of patients younger than two years old followed the CDR while 15% did not follow the CDR. Fifty-seven percentage of patients older than two years old followed the CDR while 43% did not follow the CDR.

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Table 2 Degree of agreement between PECARN CDR and CT scan ordering:

<table>
<thead>
<tr>
<th></th>
<th>Patient followed guidelines</th>
<th>Patient followed guidelines</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p&lt;0.01</td>
<td>p&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>n.</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>CT scan ordered</td>
<td>43</td>
<td>70.49%</td>
<td>35</td>
</tr>
<tr>
<td>CT scan not</td>
<td>18</td>
<td>29.51%</td>
<td>1</td>
</tr>
<tr>
<td>ordered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>62.89%</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 3 Outcome of patients regarding PECARN CDR during the first 24 hours at ED:

<table>
<thead>
<tr>
<th></th>
<th>Patient followed guidelines</th>
<th>Patients did not follow guidelines</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n.</td>
<td>%</td>
<td>n.</td>
</tr>
<tr>
<td>Discharged on</td>
<td>26</td>
<td>42.6%</td>
<td>36</td>
</tr>
<tr>
<td>instructions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observation in the ER and/or neurosurgical consultation</td>
<td>22</td>
<td>36%</td>
<td>0</td>
</tr>
<tr>
<td>Surgical</td>
<td>7</td>
<td>11.5%</td>
<td>0</td>
</tr>
<tr>
<td>intervention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admission in the inward</td>
<td>6</td>
<td>9.8%</td>
<td>0</td>
</tr>
<tr>
<td>ICU admission(need for endotracheal intubation)</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>62.89%</td>
<td>36</td>
</tr>
</tbody>
</table>

patients younger than 24 months old (a multi-center retrospective study that was conducted at the Emergency Department of four hospitals in Spain that provides different levels of health care), the hospitals were the Hospital Universitario Cruces, the Hospital Universitario Rio Hortega, the Hospital Clinico Universitario de Valladolid and the Hospital Nuestra Señora de Sonsoles, Spain, (2013) which revealed that the level of compliance with PECARN CDR for head trauma in patients younger than 24 months old was low with average 62.2% compliance to the CDR.[11]

In contrast to the present study which revealed that the adherence to PECARN CDR was 85% in children younger than two years old. This difference may be due to, 1) Roberto Velasco) is a multi-center study that was conducted in four hospitals which provide different levels of health care while the present study is a single center study (ED of SCU Hospital), 2) Roberto Velasco et al. (2014) sample size was 1361 patients (total of four hospitals), while in the present study the sample size was 97 patients.

Roberto Velasco revealed that falls were the most common cause of mTBI (72%) of patients, the Direct head injury was the second common cause (13.9%) of patients. Similar to the present study falling from a height (FFH) was the most common cause of mTBI (60% of patients) and the direct head injury was the second common cause (30% of patients). This similarity is due to, 1) Roberto Velasco et al. (2014) was the only study conducted among children younger than 2 years old, 2) Falls are usually the most common mechanism of injury in children due to physiological and anatomical differences as larger head size and weight in relation to whole body and less coordination and balancing problems during the first few years of life.[11]

Martin H. Osmond investigated CATCH (Canadian Assessment of Tomography for Childhood Head Injury) rule as clinical decision rule for the use of computed tomography in children with minor head injury (a prospective cohort study conducted in 10 Canadian pediatric teaching institutions targeted at children from 0-16 years old with acute minor head trauma presented
to the Emergency Departments, Canada, 2010) which revealed that falls were the most common mechanism of injury (44.9% of patients), Sport related injuries were the second common mechanism (22.6% of patients), and Direct head injury was the third most common cause (11.6% of patients). Motor vehicle accidents, however, were not as frequent (3.4% of patients). In contrast to the present study, in patients older than two years old RTA was the most common mechanism of injury. Also, sport-related injuries were not included in the present study.[12]

Joshua s. Easter investigated the diagnostic accuracy of clinical decision rules (PECARN, CATCH, and CHALICE), and Physician estimates for identifying clinically significant traumatic brain injury (ci TBI)* *ci TBI: clinically important Traumatic Brain Injury as defined by death from TBI, need for Neurosurgery, intubation more than 24 hours for TBI, or Hospital admission more than two nights for TBI. (a prospective cohort study conducted at Emergency Department at Denver Health Medical Center, 2014) Which revealed that falls were the most common mechanism of injury (60% of patients). In contrast to the present study regarding patients older than two years old, RTA was the most common mechanism of injury.[8]

Martin H. Osmond et al. (2010), and Joshua s. Easter et al. (2014) all revealed that falls were the most common mechanism of injury. Similar to the present study in children younger than two years old which revealed that falls were the most common mechanism of injury (60% of patients) and direct head injury as the second common cause (30% of patients). Falls are usually the most common mechanism of injury in children due to, 1) physiological and anatomical differences as larger head size and weight about the whole body, 2) less coordination and balancing problems during the first few years of life.[8-12]

However, in patients older than two years old RTA was the most common mechanism of injury (62.3% of patients), and FFH was the second common cause (19.5% of patients). This difference could be due to, 1) different distribution patterns of mechanism of injury between developed and developing countries as RTA have the highest incidence rates in developing countries, 2) lack of cultural awareness of safety measures for children while driving like seat belts, baby seats, 3) most of these studies are multicenter with different levels of health care provided.

Nathan Kuppermann revealed that 14% of patients were classified as High Risk, 29% as Intermediate Risk and 57% as Low Risk of developing (ci TBI). While in present study 20.6% of patients were classified as High Risk, 45.3% as Intermediate Risk, and 35% as the Low risk of developing (ci TBI). This difference could be due to, 1) different sample size, 2) different study design (Nathan Kuppermann et al. (2009) was a multicenter cohort study), 3) patients with GCS=13 were not included in Nathan Kuppermann et al. (2009). [13]

Deborah Schonfeld investigated the reliability of Pediatric Emergency Care Applied Research Network (PECARN) head injury clinical prediction rules in practice, (a cross-sectional study that was conducted at the PED in Boston, Massachusetts (USA) and Padova (Italy), 2014) revealed that 54% of patients were classified as Low Risk of developing (ci TBI), 38% were classified as High Risk, 45.3% as Intermediate Risk, and 35% as the Low risk of developing (ci TBI). This may be due to, 1) different sample sizes as Deborah Schonfeld et al. (2014) sample size was 2439 patients, 2) In Deborah Schonfeld et al. (2014) target age groups were < 18 years old in Boston and < 15 years old in Padova, 3) patients with GCS=13 were not included in Deborah Schonfeld et al. (2014) study.[1]

Deborah Schonfeld revealed that CT scan was ordered in 70% of patients classified as High Risk, 22% of patients classified as Intermediate Risk, and 3% of patients classified as Low Risk. In contrast to the present study CT scan was ordered in all patients classified as High Risk, 90% of patients classified as Intermediate Risk, and 51.5% of patients classified as Low Risk as this could be due to, 1) In Deborah Schonfeld et al. (2014) the PECARN CDR were applied in 99.5% of patients aiming to measure its reliability as a prediction rule, 2) different sample sizes and study designs.[1]

Silvia Bressan revealed that 0.8% of patients in the post-implementation period met the definition of (ci TBI) because of hospital admission of two nights or more due to TBI. No patient died, needed neurosurgery, or was intubated for longer than 24 hours. In contrast to present study which revealed that 13.4% of patients met the definition of ci TBI (7 patients needed neurosurgical intervention, six patients required inward admission, no patient died or needed ICU admission). This contrast could be due to a different mechanism of injuries between Silvia Bressan et al. (2012) and the present study. As falls were the most common mechanism of injury in Silvia Bressan et al. (2012), while RTA was the most common mechanism of injury in the present study which leads to different patterns and severity of injuries.[10] Deborah Schonfeld revealed that 19 patients (0.8% of all patients) met the definition of ci TBI. In contrast to present study where 13 patients (13.4% of patients) met the definition of ci TBI. This distinction is due to, 1) different study designs and sample sizes, 2) different patterns and severity of injuries, 3) Deborah Schonfeld et al. (2014) was a post-implementation study to validate the PECARN CDR where the rule was applied in 99.5% of all patients.

Recommendations:

- Increase the awareness of the emergency physicians about the risks of radiation in children.
- Increase the awareness of the emergency physicians about the importance of applying CDRs regarding the indications of CT scan ordering in mild Traumatic Brain Injury (mTBI) in patients 18 years old and younger.
- Increase the awareness of the emergency physicians of the PECARN CDR.
- Implementation of the PECARN CDR which will lead to decrease CT scan ordering in children with mTBI.
- The post-implementation study should be conducted to evaluate CT scan ordering after the implementation of the PECARN CDR.

Limitations

This study suffered some limitations, 1) some patients or their parents refused to be enrolled in this study, 2) some ER physicians were aware of this study, 3) this study was conducted in one center (the ED of SCU Hospital), 4) in younger patients sometimes it was hard to get clear information from the family regarding trauma history and symptoms, 5) some parents exaggerated the history of trauma or symptoms to get a CT scan.

Competing Interests

The authors declare no conflict of interest.

References


