Compliance with evidence-based guidelines for computed tomography of children with head and abdominal trauma

CrossMark

Ihab Halaweish *, Jane Riebe-Rodgers, Amy Randall, Peter F Ehrlich

Section of Pediatric Surgery, Department of Surgery, University of Michigan, Ann Arbor, Michigan

ARTICLE INFO

ABSTRACT

Introduction: Recently, two large prospective clinical trials developed and validated prediction rules for children at very low risk for clinically important traumatic brain injuries (ciTBI) or abdominal injury for whom CT is unnecessary. Specific criteria/guidelines were identified which if met would obviate the need for CT scanning. The purpose of this study was to assess compliance at a level one pediatric center with these guidelines as a tool for quality improvement.

Methods: Records of children admitted to our pediatric trauma center one year before and two years after publication of head (Kuppermann '09) and abdominal trauma (Holmes '13) CT imaging guidelines were reviewed. Data collected included demographics, Glasgow coma score, (GCS), injury severity score (ISS), mechanism of injury, and indication for imaging based on criteria/guidelines from the prediction rule including history, symptoms, and physical exam findings.

Results: There were 296 total patients identified. Demographic data, GCS, ISS, and mechanism of injury were similar between both groups before and after guideline publication. Prior to publication of head trauma imaging guidelines, 20.7% of head trauma patients had no indication for head CT prior compared with 19.5% after publication of imaging guideline ($p = 0.85$). Prior to publication of abdominal trauma imaging guidelines, 28.9% of patients had no indication for abdominal CT compared with 31.5% after publication of imaging guidelines (0.76). The rate of ciTBI requiring intervention was 4.6% before and 1.1% after guideline publication ($p = 0.4$). The rate of abdominal injury requiring intervention was 7.9% before and 1.8% post guideline publication ($p = 0.2$). None of the children at very low risk for ciTBI or abdominal injury required surgical intervention.

Conclusion: At our institution compliance with evidence-based guidelines for CT of children with head and abdominal trauma is poor with a significant number of patients undergoing unnecessary imaging. This provides an opportunity for quality improvement with evidence based methods to reduce unnecessary imaging for trauma.

Level of evidence: III

Type of study: Clinical Research Paper

Head and abdominal traumas are leading causes of death in children [1]. Early identification of injured children is essential to minimize morbidity and mortality from delayed or missed diagnosis. Computed tomography (CT) is the reference standard for emergently diagnosing head and abdominal trauma. In the past two decades, use of CT has increased substantially, including a fivefold increase in the number of pediatric emergency department (ED) visits that included CT [2]. This rise in CT use has triggered alarm as ionizing radiation from CT scans has been associated with an increased risk of developing subsequent malignancies [3]. Many of these children do not need to undergo CT scan; however until recently there were no guidelines to guide physicians on who needs a CT scan and who does not. To appropriately identify injured patients who do not need head and abdominal CT imaging, two large prospective clinical trials developed and validated prediction rules for children at very low risk for clinically important traumatic brain injuries (ciTBI) or abdominal injury for whom CT is unnecessary [4,5]. Specific criteria and guidelines were identified which if met would obviate the need for CT scanning. After developing and validating these data, the next step is to

Table 1
Prediction criteria for ciTBI in children younger than 2 years and aged 2 years and older

Prediction Criteria <2 yo	Prediction Criteria ≥2 yo
Altered mental status	Altered mental status
Loss of consciousness	Loss of consciousness
Skull fracture	History of vomiting
Scalp hematoma	Clinical signs of basilar skull fracture
Abnormal per parent	Severe headache
Severe Mechanism	Severe Mechanism

determine whether these guidelines are being utilized by institutions. The purpose of this study was to assess compliance at a level one pediatric center with these guidelines as a tool for quality improvement.

1. Methods

1.1. Study design

The study was approved by the University institutional review board. Records of children admitted to our pediatric trauma center were reviewed one year before and two years after publication of head (Kuppermann et al) [5] and abdominal trauma (Holmes et al) [4] CT imaging guidelines. We follow Advanced Trauma Life Support protocols for initial resuscitation and management. Prior to the publication of these guidelines, we did not use specific institutional criteria for imaging of head and trauma patients — decisions were made by the clinician using best judgement. We chose to evaluate compliance with the guidelines two years after publication to allow for these guidelines to be widely published and disseminated into practice. Data collected included demographics, mechanism of injury, injury severity score (ISS) and indication for imaging based on criteria/guidelines from the prediction rule including history, symptoms, and physical exam findings (Tables 1–2). We defined patients meeting criteria for imaging as those who had one more criteria for imaging based on the predictive criteria from the published guidelines. Patients transferred from outside hospitals were excluded.

1.2. Statistics

Data were collected using Excel Software (2007 Microsoft Corp., Redmond, Washington). Data analysis was performed with Prism (2013 GraphPad Software Inc., San Diego, California). Categorical variables were summarized by frequencies and percentages, and were analyzed using chi-square test. Continuous variables are presented as mean ± standard error of the mean. Student t test for independent samples was used to test for statistically significant differences between the groups.

Table 2
Prediction criteria for children with intraabdominal injuries

Prediction Criteria
Abdominal wall trauma or seat belt sign
GCS Score < 14
Abdominal tenderness
Thoracic wall trauma
Abdominal pain
Absent or decreased breath sounds
Vomiting

GCS = Glasgow coma score

Table 3
Head trauma patient demographics[a]

Demographics	Pre	Post
(n)	87	87
Dates	Jan '08–Dec '08	Feb '13–Oct '14
Age, y	9.4 ± 6	10.0 ± 5.8
Gender (% male)	69	61
GCS	14.9 ± 0.3	14.9 ± 0.3
LOS, d	2.2 ± 2.0	2.7 ± 3.9
ICU LOS, d	0.4 ± 0.9	0.7 ± 1.7
ISS	8.2 ± 6.5	7.9 ± 6.3
Severe Mechanism[a]	32/87 (36.8%)	25/87 (28.7%)

Plus–minus values are means ± SD. There were no significant differences between groups. GCS = Glasgow coma score, LOS = length of stay, ICU = intensive care unit, ISS = injury severity score.
[a] MVC with rollover, patient ejection, or passenger death; unhelmeted bicycle vs. auto; head struck by high impact object; high level falls.

2. Results

2.1. Head trauma

We reviewed a total of 296 patients including 166 patients with head trauma and 130 with abdominal trauma. Within the head trauma patients, there were 87 patients admitted one year before publication of guidelines and 87 patients two years after. There were no significant differences in demographic and clinical data before and after guideline publication (Table 3). The mean age was 9.4 ± 6 years before guideline publication and 10.0 ± 5.8 after guideline publication. The mean GCS was 14.9 ± 0.3 before guideline publication and 14.9 ± 0.3 after guideline publication. The percentage of patients with a severe mechanism of injury (motor vehicle collision (MVC) with rollover, patient ejection, or passenger death; unhelmeted bicycle vs. auto; head struck by high impact object; high level falls) was 36.8% before guideline publication and 28.7% after guideline publication (all $p < 0.05$).

Prior to publication of imaging guidelines, 76.5% of patients <2 years old and 80% of patients ≥2 years old met criteria for head CT, compared with 67% of patients <2 years old and 82.3% of patients ≥2 years after publication of imaging guidelines ($p = 0.56$ and 0.68, respectively). Overall, 20.7% of head trauma patients had no indication for head CT prior to publication of imaging guidelines compared with 19.5% after publication of imaging guideline ($p = 0.85$), thus indicating poor compliance with published guidelines.

There were no significant differences in clinically significant TBI (admission >2 nights for TBI, neurosurgery intervention, death from TBI, intubation >24 h) before or after guideline publication (Table 4). None of the patients that did not meet criteria for head CT imaging required an intervention secondary to clinically significant TBI.

2.2. Abdominal trauma

Within the patients with abdominal trauma, there were 76 admitted one year before publication of guidelines and 54 two years after. There were no significant differences in demographic and clinical data before and after guideline publication (Table 5). The mean age was 10.3 ± 5.1 years before guideline publication and 11.7 ± 5.1 after guideline publication. The mean ISS was 10.0 ± 7 before guideline publication

Table 4
Outcomes head trauma patients

Outcome	Pre	Post	P value
Clinically Significant TBI			
Admission >2 Nights for TBI	1/87 (1.1%)	4/87 (4.6%)	0.17
Neurosurgery intervention	4/87 (4.6%)	1/87 (1.1%)	0.17
Intubation >24 h for TBI	0	1/87 (1.1%)	0.32
Death from TBI	0	0	–