Variation in Specialists’ Reported Hospitalization Practices of Children Sustaining Blunt Head Trauma

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INTRODUCTION

Traumatic brain injury (TBI) is a leading cause of death in children older than 1 year of age and a significant cause of morbidity. Between 2002 and 2006 the estimated annual number of TBIs in children less than 15 years of age in the U.S. was approximately 511,000, including approximately 2,200 deaths, 35,000 hospitalizations, and 474,000 emergency department (ED) visits. Cranial computed tomography (CT) is the diagnostic test of choice for evaluating children with blunt head trauma in the ED. Fewer than 10% of these CTs, however, are diagnostic of TBI. Furthermore, the implications of small traumatic findings on CT are not clear. Therefore, CT should ideally be selectively used with the goal of identifying clinically-important findings.

Several large studies have suggested that the presence or absence of certain clinical signs and symptoms are predictive of a TBI requiring acute intervention, such as hospitalization, neurological surgery, or on-going anti-epileptic pharmacotherapy. Studies such as these have caused investigators to question the necessity of identifying children with TBIs that are not clinically important. With newer generation helical CT scanners, TBIs not identified...
20 years ago are now being more readily visualized. Furthermore, with more sensitive neuroimaging tools, such as magnetic resonance imaging (MRI) and single-photon emission computed tomography (SPECT) brain perfusion imaging, TBIs not visible on cranial CT are also being identified.\(^{15,16}\) Considering this rapid pace of technological developments in neuroimaging, future modalities will likely identify even smaller, more subtle TBIs, and challenge current neuroimaging decision rules that focus on TBI identified on cranial CT.

Current clinical practice patterns result in a number of neurologically-normal children with small TBIs undergoing cranial CT and hospitalization for observation despite the lack of need for acute intervention.\(^3,9\) The potential inefficiency in this practice prompted us to seek the opinion of specialists on what constitutes a clinically-significant TBI on CT scan for the purposes of hospitalization and acute management. Our objective was to identify variations and factors associated with ED disposition of neurologically-normal children with blunt head trauma and different traumatic cranial CT findings. We hypothesized that substantial variation in practice exists among physicians caring for neurologically-normal children with TBIs on CT and that factors associated with this variation can be identified.

**METHODS**

**Study Design and Population**

We surveyed by electronic and regular mail, physicians caring for children with blunt head trauma practicing in all U.S. pediatric Level I and Level II trauma centers, children’s hospitals, and trauma centers with a pediatric commitment between July 2006 and May 2007. We compiled a mailing list from information obtained through the American College of Surgeons (ACS), the National Association of Children’s Hospitals and Related Institutions (NACHRI), and websites of verified ACS and NACHRI member institutions. We surveyed all physicians trained in pediatric emergency medicine (PEM),

### Table 1. Characteristics of survey respondents.

| Demographic                     | n=636 | %   |
|---------------------------------|-------|-----|
| **Physician characteristics**   |       |     |
| Practice specialty              |       |     |
| Pediatric emergency medicine    | 336   | 47  |
| General emergency medicine      | 161   | 22  |
| Pediatric neurosurgery          | 58    | 8   |
| General neurosurgery            | 21    | 3   |
| Pediatric surgery               | 76    | 11  |
| Trauma surgery                  | 48    | 7   |
| Other                           | 15    | 2   |
| **Years in practice**           |       |     |
| 0-5 years                       | 173   | 24  |
| 6-10 years                      | 167   | 24  |
| 11-15 years                     | 144   | 20  |
| > 15 years                      | 231   | 32  |
| **Percentage of patients that are children** |       |     |
| 0-10%                           | 83    | 12  |
| 11%-30%                         | 151   | 21  |
| 31%-50%                         | 25    | 3   |
| 51%-95%                         | 51    | 7   |
| > 95%                           | 405   | 57  |
| **Hospital characteristics**    |       |     |
| Annual ED pediatric volume      |       |     |
| < 20,000                        | 166   | 23  |
| 20,000-40,000                   | 190   | 27  |
| 40,000-60,000                   | 177   | 25  |
| > 60,000                        | 182   | 25  |
| Practice setting*               |       |     |
| Children’s hospital             | 416   | 58  |
| General hospital                | 220   | 31  |
| Private hospital                | 143   | 20  |
| Academic hospital               | 481   | 67  |
| Geographic location             |       |     |
| Urban (> 50,000 pop)            | 651   | 91  |
| Non-urban (< 50,000 pop)        | 64    | 9   |

*ED, emergency department

**Table 2. Overall emergency department discharge rates by isolated cranial computed tomography (CT) finding.**

| CT finding                          | Case 1 | Case 2 |
|-------------------------------------|--------|--------|
| Linear nondisplaced skull fracture  | 71%    | 62%    |
| Diastatic (widened) skull fracture  | 26%    | 22%    |
| Depressed skull fracture            | 19%    | 17%    |
| Basilar skull fracture              | 23%    | 17%    |
| Pneumocephalus                      | 9%     | 7%     |
| Small intracerebral hemorrhage      | 10%    | 6%     |
| Small subarachnoid hemorrhage       | 9%     | 7%     |
| Small intraventricular hemorrhage   | 4%     | 3%     |
| Subdural hematoma                   | 6%     | 4%     |
| Epidural hematoma                   | 2%     | 2%     |
Survey Content and Administration

In the survey we presented case studies of 2 hypothetical neurologically-normal children with blunt head trauma: Case 1, a 9-year-old boy who fell 10 feet from a tree landing on dirt with unknown history of loss of consciousness; and Case 2, an 11-month-old girl crying vigorously and attempting to crawl after falling 5 feet from the sibling’s bunk bed with an unknown history of loss of consciousness. Both patients were further described as being asymptomatic and having normal neurological examinations after 4 hours of ED observation. Survey participants were asked whether they would be willing to discharge the patients home to reliable parents with good follow up, given any of the following 10 differing isolated, traumatic cranial CT findings: linear nondisplaced skull fracture, diastatic (widened) skull fracture, depressed skull fracture (less than the table width of the skull), basilar skull fracture, pneumocephalus, very small subarachnoid hemorrhage, very small intraventricular hemorrhage, subdural hematoma without midline shift, epidural hematoma without midline shift, and small intracerebral hemorrhage. The survey instrument also included 7 items pertaining to participants’ demographic characteristics.

We contacted participants via electronic mail in July 2006 and invited them to participate in the web-based survey. Each participant was provided with a hyperlink text to gain access to the questionnaire. For physicians with undeliverable e-mail addresses, we sent the survey via U.S. Postal Service in August 2006. Non-responders to the initial e-mail survey were sent a second e-mail request for participation in September 2006 with the survey attached as an electronic PDF document. We sent physicians who did not respond to the web-based or electronic surveys a cover letter and survey by U.S. Postal Service in December 2006. A final mailing to non-responders was distributed by U.S. Postal Service in February 2007.

Data Analysis

We entered data into a Microsoft Access database (Microsoft Corp., Redmond, WA) and analyzed it using

| Case 1 emergency department discharge rates by practice specialty. |
|---------------------------------------------------------------|
|                  PEM (n=336)          | GEM (n=161) | PNSG (n=58) | GNSG (n=21) | PS (n=76) | TS (n=48) |
| Linear nondisplaced skull fracture*** | 86%         | 63%         | 64%         | 55%       | 39%       | 55%       |
| Diastatic (widened) skull fracture*** | 33%         | 16%         | 29%         | 29%       | 12%       | 26%       |
| Depressed skull fracture** | 25%         | 14%         | 22%         | 29%       | 5%        | 15%       |
| Basilar skull fracture*** | 28%         | 22%         | 33%         | 33%       | 0%        | 11%       |
| Pneumocephalus* | 10%         | 8%          | 16%         | 20%       | 1%        | 4%        |
| Small intracerebral hemorrhage*** | 9%          | 11%         | 21%         | 33%       | 2%        | 2%        |
| Small subarachnoid hemorrhage*** | 7%          | 6%          | 31%         | 30%       | 1%        | 6%        |
| Small intraventricular hemorrhage** | 5%          | 2%          | 10%         | 20%       | 1%        | 2%        |
| Subdural hematoma | 6%          | 6%          | 7%          | 15%       | 1%        | 2%        |
| Epidural hematoma*** | 1%          | 1%          | 13%         | 7%        | 0%        | 2%        |

**PEM, pediatric emergency medicine; GEM, general emergency medicine; PNSG, pediatric neurosurgery; GNSG, general neurosurgery; PS, pediatric surgery; TS, trauma surgery

Overall significant differences (by Chi-square test of homogeneity of proportions, with 5 degrees of freedom):

* P < 0.05; ** P < 0.01; *** P < 0.001

Two-way significant differences (using Holm correction for Bonferroni multiple test procedure):

1PEM v. GEM, PNSG, GNSG, PS, and TS; GEM v. PS; PNSG v. PS
2PEM v. GEM and PS
3PEM v. GEM and PS; PNSG v. PS; GNSG v. PS
4PEM v. PS; GEM v. PS; PNSG v. PS; GNSG v. PS; PS v. TS
5PNSG v. PS; GNSG v. PS
6PNSG v. PS; GNSG v. PS and TS
7PEM v. PNSG and GNSG; GEM v. PNSG and GNSG; PNSG v. PS and TS; GNSG v. PS
8GEM v. GNSG; GNSG v. PS
9PEM v. PNSG; GEM v. PNSG
Table 4. Case 2 emergency department discharge rates by practice specialty.

|                         | PEM (n=336) | GEM (n=161) | PNSG (n=58) | GNSG (n=21) | PS (n=76) | TS (n=48) |
|-------------------------|-------------|-------------|-------------|-------------|-----------|-----------|
| Linear nondisplaced skull fracture*** | 78% | 48% | 60% | 52% | 37% | 45% |
| Diastatic (widened) skull fracture*** | 29% | 14% | 29% | 33% | 7% | 15% |
| Depressed skull fracture*** | 23% | 9% | 26% | 33% | 4% | 11% |
| Basilar skull fracture*** | 20% | 13% | 26% | 29% | 1% | 15% |
| Pneumocephalus | 9% | 5% | 11% | 15% | 1% | 2% |
| Small intracerebral hemorrhage* | 6% | 5% | 13% | 20% | 2% | 2% |
| Small subarachnoid hemorrhage*** | 6% | 5% | 23% | 25% | 3% | 4% |
| Small intraventricular hemorrhage*** | 3% | 1% | 11% | 15% | 1% | 2% |
| Subdural hematoma | 5% | 3% | 9% | 5% | 1% | 2% |
| Epidural hematoma | 1% | 2% | 4% | 0% | 0% | 2% |

Overall significant differences (by Chi-square test of homogeneity of proportions, with 5 degrees of freedom): * P < 0.05; *** P < 0.001

Two-way significant differences (using Holm correction for Bonferroni multiple test procedure):

- PEM v. GEM, PNSG, PS, and TS
- PEM v. GEM and PS; PNSG v. PS; GNSG v. PS
- PEM v. GEM and PS; GEM v. PNSG and GNSG; PNSG v. PS; GNSG v. PS
- PEM v. PS; PNSG v. PS; GNSG v. PS; PS v. TS
- Significance on overall chi-square, but no pairwise significant differences.
- PEM v. PNSG and GNSG; GEM v. PNSG and GNSG; PNSG v. PS; GNSG v. PS
- PEM v. PNSG and GNSG; GEM v. PNSG and GNSG

Stata/SE 8.2 for Windows (Version 8, StataCorp LP, College Station, TX). We assessed overall significant differences between practice specialties and disposition with chi-square tests. Post hoc testing was conducted using Holm’s correction for Bonferroni multiple test procedure. Because there were so few (15) surveys returned from practitioners in the “other” practice specialty group, we removed these from further analysis. We then performed backward stepwise multivariable logistic regression to examine the impact of physician characteristics (practice specialty, years in practice, and percentage of patients in their practices who are children) and hospital characteristics (annual ED pediatric patient volume, practice setting, and geographic location) on disposition decision-making for each hypothetical patient with any of the 10 cranial CT findings. Pediatric EPs, > 15 years of practice, and > 95% pediatric patients were selected as reference standards for data analysis because they were the most populous subgroups. We also selected pediatric ED volume of > 60,000 as the reference standard group, as the frequency of all ED volume categories were nearly equivalent. Results are presented with odds ratios (OR) with 95% confidence intervals (CI).

RESULTS

We distributed 2,799 surveys. Three hundred sixty-seven were ultimately undeliverable. Ninety-one respondents were ineligible to participate in the survey (90 did not care for children younger than 18 years with trauma and one was a nurse practitioner). In total, 715 (31%) of 2,341 eligible participants responded to the survey. Response rates within subspecialty were pediatric emergency medicine 336/878 (38%), general emergency medicine 161/645 (25%), pediatric neurosurgery 58/135 (43%), general neurosurgery 21/203 (10%), pediatric surgery 76/387 (20%), and trauma surgery 48/93 (52%).

Physician and hospital characteristics of respondents are shown in Table 1. Nearly one-half of all participants specialize in PEM. One-third have more than 15 years of practice experience. Most respondents care almost exclusively for pediatric patients. Participants were evenly distributed across the 4 categories representing annual pediatric patient volume. Most respondents practice in urban areas.

Overall patient discharge rates by isolated CT finding for Case 1 and Case 2 are shown in Table 2. Most respondents would discharge patients having isolated linear, non-displaced skull fractures. Up to 1 quarter of respondents would discharge patients with diastatic (widened) skull fractures, depressed skull fractures, or basilar skull fractures. Few respondents would discharge patients with pneumocephalus, small intracerebral hemorrhage, subarachnoid or very small intraventricular hemorrhages, subdural or epidural hematomas. Discharge rates by practice specialty for both cases are reported in Tables 3 and 4.

The statistically significant results of the multivariable analyses for the 2 cases are shown in Tables 5 and 6, respectively. Pediatric surgeons were least likely to discharge
### Table 5. Case 1 physician and hospital predictors of patient discharge on multivariate analysis.

|                        | Linear nondisplaced skull fracture | Diastatic (widened) skull fracture | Depressed skull fracture | Basilar skull fracture | Pneumocephalus | Small intracerebral hemorrhage | Small subarachnoid hemorrhage | Small intraventricular hemorrhage | Subdural hematoma | Epidural hematoma |
|------------------------|-----------------------------------|-----------------------------------|--------------------------|------------------------|-----------------|-------------------------------|-------------------------------|-------------------------------|------------------|------------------|
| **Practice specialty** |                                   |                                   |                          |                        |                 |                                |                                |                                |                  |                  |
| Pediatric EM           | ref                               | ref                               | ref                      | ref                    | ref             | ref                           | ref                           | ref                           | ref              | ref              |
| General EM             | ns                                | 0.41 (0.26,0.65)                  | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| Pediatric neurosurgery| 0.41 (0.22,0.75)                  | ns                                | ns                       | ns                     | 2.53 (1.17,5.48) | 6.87 (3.60,13.10)            | ns                            | ns                            | 9.31 (2.99,28.96)| ns               |
| General neurosurgery   | ns                                | ns                                | ns                       | ns                     | 5.95 (1.88,18.85)| 6.54 (2.38,17.98)           | ns                            | ns                            | ns               | ns               |
| Pediatric surgery      | 0.14 (0.08,0.23)                  | 0.32 (0.16,0.62)                  | 0.25 (0.11,0.60)         | ns                     | 0.09 (0.01,0.67) | 0.13 (0.02,0.97)            | ns                            | ns                            | ns               | ns               |
| Trauma surgery         | ns                                | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| **Years in practice** |                                   |                                   |                          |                        |                 |                                |                                |                                |                  |                  |
| 0-5 years              | ns                                | ns                                | 0.52 (0.32,0.86)         | 0.58 (0.37,0.92)       | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| 6-10 years             | ns                                | ns                                | ns                       | ns                     | 2.26 (1.31,3.91) | ns                            | ns                            | ns                            | ns               | ns               |
| 11-15 years            | 1.83 (1.13,2.95)                  | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| > 15 years             | ref                               | ref                               | ref                      | ref                    | ref             | ref                           | ref                           | ref                           | ref              | ref              |
| **Percentage of patients who are children** |                                   |                                   |                          |                        |                 |                                |                                |                                |                  |                  |
| 0-10%                  | ns                                | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| 11%-30%                | ns                                | ns                                | ns                       | 0.57 (0.35,0.94)       | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| 31%-50%                | ns                                | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| 51%-95%                | ns                                | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| > 95%                  | ref                               | ref                               | ref                      | ref                    | ref             | ref                           | ref                           | ref                           | ref              | ref              |
| **Annual ED peds volume** |                                   |                                   |                          |                        |                 |                                |                                |                                |                  |                  |
| < 20,000               | ns                                | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| 20,000-40,000          | ns                                | ns                                | ns                       | ns                     | 0.45 (0.22,0.91)| 0.45 (0.21,0.96)           | ns                            | ns                            | ns               | ns               |
| 40,000-60,000          | ns                                | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| > 60,000               | ref                               | ref                               | ref                      | ref                    | ref             | ref                           | ref                           | ref                           | ref              | ref              |
| **Practice setting**   |                                   |                                   |                          |                        |                 |                                |                                |                                |                  |                  |
| Children's hospital    | 3.11 (2.10,4.59)                  | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| General hospital       | ns                                | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| Private hospital       | ns                                | ns                                | 2.04 (1.31,3.18)         | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| Academic hospital      | ns                                | ns                                | ns                       | ns                     | ns              | ns                            | ns                            | ns                            | ns               | ns               |
| Geographic location    |                                   |                                   |                          |                        |                 |                                |                                |                                |                  |                  |
| Urban (> 50,000 pop)   | ns                                | ns                                | ns                       | 2.22 (1.02,4.81)       | ns              | ns                            | ns                            | ns                            | ns               | ns               |

*EM, emergency medicine; ns, not significant; ref, reference group*
Table 6. Case 2 physician and hospital predictors of patient discharge on multivariate analysis.

|                          | Linear nondisplaced skull fracture | Diastatic (widened) skull fracture | Depressed skull fracture | Basilar skull fracture | Pneumocephalus | Small intracerebral hemorrhage | Small subarachnoid hemorrhage | Small intraventricular hemorrhage | Subdural hematoma | Epidural hematoma |
|--------------------------|-----------------------------------|-----------------------------------|--------------------------|------------------------|----------------|--------------------------------|-------------------------------|---------------------------------|-----------------|-----------------|
| Practice specialty       |                                   |                                   |                          |                        |                |                                |                               |                                 |                 |                 |
| Pediatric EM             | ref                               | ref                               | ref                      | ref                    | ref            | ref                            | ref                           | ref                             | ref             | ref             |
| General EM               | ns                                | ns                                | 0.33 (0.18,0.58)         | 0.54 (0.32,0.90)       | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| Pediatric neurosurgery   | 0.55 (0.30,1.00)                  | ns                                | ns                       | ns                     | ns             | 5.38 (2.64,10.99)              | 4.39 (1.64,11.74)             | ns                              | ns               | ns              |
| General neurosurgery     | ns                                | ns                                | ns                       | ns                     | ns             | 6.07 (2.08,17.76)              | ns                            | ns                              | ns               | ns              |
| Pediatric surgery        | 0.18 (0.11,0.30)                  | 0.24 (0.11,0.54)                  | 0.21 (0.08,0.55)         | 0.04 (0.01,0.31)       | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| Trauma surgery           | ns                                | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| Years in practice        |                                   |                                   |                          |                        |                |                                |                               |                                 |                 |                 |
| 0-5 years                | ns                                | 0.55 (0.34,0.87)                  | 0.34 (0.19,0.61)         | 0.58 (0.35,0.98)       | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| 6-10 years               | ns                                | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| 11-15 years              | 1.70 (1.10,2.63)                  | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| >15 years                | ref                               | ref                               | ref                      | ref                    | ref            | ref                            | ref                           | ref                             | ref             | ref             |
| Percentage of patients   |                                   |                                   |                          |                        |                |                                |                               |                                 |                 |                 |
| who are children         |                                   |                                   |                          |                        |                |                                |                               |                                 |                 |                 |
| 0-10%                    | 0.20 (0.12,0.35)                  | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| 11%-30%                  | 0.22 (0.14,0.34)                  | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| 31%-50%                  | ns                                | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| 51%-95%                  | ns                                | 1.89 (1.00,3.54)                  | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| >95%                     | ref                               | ref                               | ref                      | ref                    | ref            | ref                            | ref                           | ref                             | ref             | ref             |
| Annual ED peds volume    |                                   |                                   |                          |                        |                |                                |                               |                                 |                 |                 |
| <20,000                  | ns                                | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| 20,000-40,000            | 0.57 (0.38,0.85)                  | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | 0.20 (0.05,0.87) |
| 40,000-60,000            | 0.61 (0.39,0.95)                  | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| >60,000                  | ref                               | ref                               | ref                      | ref                    | ref            | ref                            | ref                           | ref                             | ref             | ref             |
| Practice setting         |                                   |                                   |                          |                        |                |                                |                               |                                 |                 |                 |
| Children’s hospital      | ns                                | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| General hospital         | ns                                | ns                                | 0.47 (0.30,0.73)         | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| Private hospital         | ns                                | ns                                | 1.87 (1.17,2.99)         | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| Academic hospital        | ns                                | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |
| Geographic location      |                                   |                                   |                          |                        |                |                                |                               |                                 |                 |                 |
| Urban (>50,000 pop)      | ns                                | ns                                | ns                       | ns                     | ns             | ns                             | ns                            | ns                              | ns               | ns              |

*EM, emergency medicine; ns, not significant; ref, reference group.*
either patient with various types of skull fractures, and physicians working in children’s hospitals were more likely
to discharge Case 1 with a linear skull fracture. In both cases,
pediatric neurosurgeons and general neurosurgeons were
more likely to discharge patients with small subarachnoid
hemorrhages, and for Case 1, they were more likely to
discharge patients with small intracerebral hemorrhages. Of
note, pediatric neurosurgeons were also substantially more
likely to discharge Case 1 with a small epidural hematoma. In
general, physicians with fewer than 5 years of experience also
had a lower odds ratio of patient discharge with several of the
CT findings.

DISCUSSION

Management of children with minor head trauma remains
controversial, and there is no clear standard of care. Not
only is there debate on which children require imaging, but
the appropriate subsequent disposition of these children
once the CT results are known is also unclear as there are
no specific guidelines. In our survey of specialists caring for
these children, we found substantial variation in the reported
hospitalization practices of neurologically-normal children
with traumatic findings on cranial CT following blunt head
trauma, despite the fact that many TBIs identified on CT
do not need acute intervention. In fact, TBIs needing
neurosurgery in children with Glasgow Coma Scale scores
of 14-15 are very uncommon. If medical or surgical
intervention is not needed, hospitalization may in fact not
be necessary, assuming the neurologically-normal child has
reliable parents, no suspicion of inflicted injuries (i.e., abuse)
and acceptable follow-up.

In the case scenarios presented, while almost two-thirds
of the specialists would discharge patients with a linear skull
fracture, a substantial number indicated that they would
still admit these children for inpatient observation. Several
previous studies have suggested that neither an isolated linear
skull fracture nor a basilar skull fracture is, by itself, an
indication for hospital admission. Children with isolated
skull fractures in the study by Beaudin et al were discharged
from the ED or the pediatric ward without complications and
could have easily been managed at home after a period of ED
observation.

All surveyed specialty groups reported that they were
less likely to discharge patients with intracranial hemorrhages
(subarachnoid, intraventricular, subdural, epidural or
intracerebral hemorrhages) as opposed to those with isolated
skull fractures. Although the reasons for this were not elicited
in this study, it is known that certain regions of the brain,
especially the medial temporal lobe and the posterior fossa,
tolerate mass effect poorly. Potential concern for enlargement
of even small hemorrhages in the subacute phase of injury
probably influences the decision to admit these patients for
observation. Interestingly, pediatric EPs were the most likely
of all the specialties to discharge patients with traumatic
findings on cranial CT from the ED. Neurosurgeons also
indicated their willingness to discharge patients with certain
CT findings. In previous research, neurosurgeons have
suggested that neurosurgical consultation is not necessary
in patients with minor TBI findings and normal neurologic
status.

LIMITATIONS

The study has several limitations. We achieved a 31%
response rate to our survey. While this compares favorably to
many recent surveys, it is unclear to what degree the practice
patterns of non-respondents may have differed from those that
responded. We also cannot be certain that the responses
to the hypothetical cases reflect the actual practice patterns of
those caring for children with blunt head trauma. Respondents
may be more willing to discharge home a theoretical
patient than an actual patient. We also surveyed only those
specialists working in major pediatric trauma centers and
children’s hospitals because we assumed that they care for a
large portion of these types of patients and considered these
clinicians to be the most knowledgeable about this issue. It is
possible that there are other clinicians who care for children
with these injuries that did not have the opportunity to respond
to our survey, and their practice patterns may differ.

CONCLUSION

Substantial variation exists between specialties in reported
hospitalization practices of neurologically-normal children
with blunt head trauma and traumatic cranial CT findings.
Pediatric neurosurgeons and general neurosurgeons are more
willing to discharge patients than are pediatric surgeons, and
other important specialty differences are evident as well.
Better evidence is needed to guide disposition decision-
making in neurologically-normal children with minor,
traumatic cranial CT findings.

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REFERENCES

1. Paul M, Xu L, Wald MW, et al. Traumatic brain injury in the united
states: emergency department visits, hospitalization and deaths,
2002-2006. Atlanta (GA): Centers for Disease Control and Prevention,
National Center for Injury Prevention and Control; 2010.
2. Homer CJ, Kleinman L. Technical report: minor head injury in children.
Pediatrics. 1999; 104:e78.
3. Palchak MJ, Holmes JF, Vance CW, et al. A decision rule for identifying
children at low risk for brain injuries after blunt head trauma. Ann Emerg Med. 2003; 42:492-506.

4. Schunk JE, Rodger JD, Woodward GA. The utility of head computed tomographic scanning in pediatric patients with normal neurologic examination in the emergency department. Pediatr Emerg Care. 1996; 12:160-5.

5. Quayle KS, Jaffe DM, Kuppermann, N, et al. Diagnostic testing for acute head injury in children: when are head computed tomography and skull radiographs indicated? Pediatrics. 1997; 99:e11.

6. Gruskin KD, Shatzman SA. Head trauma in children younger than 2 years: are there predictors for complications? Arch Pediatr Adolesc Med. 1999; 153:15-20.

7. Greenes DS, Shatzman SA. Clinical indicators of intracranial injury in head-injured infants. Pediatrics. 1999; 104:861-7.

8. Osmond MH, Klassen TP, Wells GA, et al. Catch: a clinical decision rule for the use of computed tomography in children with minor head injury. CMAJ. 2010; 182:341-8.

9. Kuppermann N, Holmes JF, Dayan PS, et al. Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. Lancet. 2009; 374:1160-70.

10. Oman JA, Cooper RJ, Holmes JF, et al. Performance of a decision rule to predict need for computed tomography among children with blunt head trauma. Pediatrics. 2006; 117:e238-46.

11. Atzema C, Mower WR, Hoffman JR, et al. Defining “clinically unimportant” CT findings in patients with blunt head trauma. Acad Emerg Med. 2002; 9:451.

12. Atzema C, Mower WR, Hoffman JR, et al. Defining “therapeutically inconsequential” head computed tomographic findings in patients with blunt head trauma. Ann Emerg Med. 2004; 44:47-56.

13. Haydel MJ, Shembekar AD. Prediction of intracranial injury in children aged five years and older with loss of consciousness after minor head injury due to nontrivial mechanisms. Ann Emerg Med. 2003; 42:507-14.

14. Dunning J, Daly JP, Lomas JP, et al. Derivation of the children’s head injury algorithm for the prediction of important clinical events decision rule for head injury in children. Arch Dis Child. 2006; 91:885-91.

15. Belanger HG, Vanderploeg RD, Curtiss G, et al. Recent neuroimaging techniques in mild traumatic brain injury. J Neuropsychiatry Clin Neurosci. 2007; 19:5-20.

16. Wilde EA, McCauley SR, Hunter JV, et al. Diffusion tensor imaging of acute mild traumatic brain injury in adolescents. Neurology. 2008; 70:948-55.

17. Holm S. A simple sequentially rejective multiple test procedure. Scand J Statist. 1979; 6:65-70.

18. Jeret JS, Mandell M, Anziska B, et al. Clinical predictors of abnormality disclosed by computed tomography after mild head trauma. Neurosurgery. 1993; 32:9-16.

19. Miller EC, Holmes JF, Derlet RW. Utilizing clinical factors to reduce head ct scan ordering for minor head trauma patients. J Emerg Med. 1997; 15:453-7.

20. Dunham CM, Coates S, Cooper C. Compelling evidence for discretionary brain computed tomographic imaging in those patients with mild cognitive impairment after blunt trauma. J Trauma. 1996; 41:679-86.

21. Kadish HA, Schunk JE. Pediatric basilar skull fracture: do children with normal neurologic findings and no intracranial injury require hospitalization? Ann Emerg Med. 1995; 26:37-41.

22. Greenes DS, Shatzman SA. Infants with isolated skull fracture: what are their clinical characteristics, and do they require hospitalization? Ann Emerg Med. 1997; 30:253-9.

23. Beaudin M, Saint-Vil D, Ouimet A, et al. Clinical algorithm and resource use in the management of children with minor head trauma. Journal of Pediatric Surgery. 2007; 42:849-52.

24. Huynh T, Jacobs D, Dix S. Utility of neurosurgical consultation for mild traumatic brain injury. The American Surgeon. 2006; 72:1162-7.

25. Krystal SL, Randall-Kristal KA, Thompson BM. The society for academic emergency medicine’s 2004-2005 emergency medicine faculty salary and benefit survey. Acad Emerg Med. 2006; 13:548-58.

26. Thurman RJ, Katz E, Carter W, et al. Emergency medicine residency applicant perception of unethical recruiting practices and illegal questioning in the match. Acad Emerg Med. 2009; 16:550-7.

27. Zonfrillo MR, Nelson KA, Durbin DR. Emergency physicians’ knowledge and provision of child passenger safety information. Acad Emerg Med. 2011; 18:145-51.