Acute outcomes of isolated cerebral contusions in children with Glasgow Coma Scale scores of 14 to 15 after blunt head trauma

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BACKGROUND: Little data exist to guide the management of children with cerebral contusions after minor blunt head trauma. We therefore aimed to determine the risk of acute adverse outcomes in children with minor blunt head trauma who had cerebral contusions and no other traumatic brain injuries on computed tomography (i.e., isolated cerebral contusions).

METHODS: We conducted a secondary analysis of a public use data set originating from a prospective cohort study performed in 25 PECARN (Pediatric Emergency Care Applied Research Network) emergency departments of children younger than 18 years with blunt head trauma resulting from nontrivial injury mechanisms and with Glasgow Coma Scale (GCS) scores of 14 or 15. In this analysis, we included only children with isolated cerebral contusions. We defined a *normal mental status* as a GCS score of 15 and no other signs of abnormal mental status. Acute adverse outcomes included intubation longer than 24 hours because of the head trauma, neurosurgery, or death from the head injury.

RESULTS: Of 14,983 children with GCS scores of 14 or 15 who received cranial computed tomography scans in the parent study, 152 (1.0%; 95% confidence interval, 0.8–1.2%) had cerebral contusions, of which 54 (35.8%) of 151 with available data were isolated. The median age of those with isolated cerebral contusions was 9 years (interquartile range, 1–13); 31 (57.4%) had a normal mental status. Of 36 patients with available data on isolated cerebral contusion size, 34 (94.4%) were described as small. 43 (79.6%) of 54 patients with isolated cerebral contusions were hospitalized, including 16 (29.6%) of 54 to an intensive care unit. No patients with isolated cerebral contusions died, were intubated longer than 24 hours for head trauma, or required neurosurgery (95% confidence interval for all outcomes, 0–6.6%).

CONCLUSION: Children with small isolated cerebral contusions after minor blunt head trauma are unlikely to require further acute intervention, including neurosurgery, suggesting that neither intensive care unit admission nor prolonged hospitalization is generally required. (*J Trauma Acute Care Surg*. 2015;78: 1039–1043. Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Epidemiologic study, level IV.

KEY WORDS: Traumatic brain injury; cerebral contusion; pediatrics; prognosis; emergency.

Traumatic brain injuries (TBIs) are among the most common serious injuries sustained by children, resulting in more than 35,000 hospital admissions and 2,100 deaths annually.[1] Cerebral contusions are one common type of TBI, essentially bruises of the brain caused by microhemorrhage. On cranial computed tomography (CT), cerebral contusions are foci of hyperdensity that typically involve the gray matter or subcortical white matter. Cerebral contusions occur in 2% to 4% of children with mild or moderate blunt head trauma who have cranial CTs obtained; however, data regarding clinical features and outcomes are lacking from well-described prospectively evaluated patient populations.[2–5]

Scant literature exists describing the acute course of children with minor blunt head trauma whose sole TBIs are cerebral contusions (i.e., an isolated cerebral contusion), particularly for children who are clinically well on presentation to the emergency department (ED). Pediatric patients with cerebral contusions are typically hospitalized for observation, frequently in intensive care units (ICUs) out of concern for progression of bleeding or edema, and/or clinical deterioration. Prior research, mainly on adults with more severe trauma, suggests that the risk of progressive bleeding increases with larger contusion size, lower initial Glasgow Coma Scale (GCS) scores, and the presence of other intracranial bleeding caused by trauma (e.g., subdural hematomas).[6–9] Our objective was to determine the risk of acute adverse outcomes in children with minor blunt head trauma who had cerebral contusions and no other TBIs on CT. These data would allow clinicians to make appropriate decisions regarding further acute management and disposition of such children.

PATIENTS AND METHODS

Study Setting and Population

We performed a secondary analysis of a deidentified public use data set originating from a prospective cohort study of children with blunt head trauma conducted at 25 sites in the PECARN (Pediatric Emergency Care Research Applied Research Network) between June 2004 and September 2006.[10] Full details of the study have been previously published.[11]

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Briefly, the parent study included children younger than 18 years who sustained blunt head trauma in the previous 24 hours. Patients with trivial mechanisms of injury (such as a ground-level falls or running into stationary objects) and no signs or symptoms of head trauma other than scalp abrasions or lacerations were excluded as were patients with penetrating head trauma, preexisting neurologic diseases, or prior neuroimaging for the head trauma. In the parent prospective cohort, ED clinicians assessed patients before knowing CT results (if obtained) and used a standard data collection tool to document patient history and physical examination findings. Cranial CTs were obtained at the discretion of the treating clinicians.[11] The present study was deemed not to be human subjects research by the local institutional review board.

We included patients in the present analysis if they had *minor blunt head trauma*, defined as GCS scores of 14 or 15, and received cranial CT scans. The GCS score was the sole clinical examination finding for inclusion in this study and was a mandatory field during data collection in the parent study. We excluded patients with bleeding diatheses or ventricular shunts. We defined a *normal mental status* as the combination of GCS scores of 15 and no other signs of abnormal mental status, both of which were collected as part of the standardized ED data collection form. A patient had no other signs of abnormal mental status if he or she had none of the following: agitation, sleepiness, slowness to respond to questioning, or asking repetitive questions.

We considered a patient to have had a cerebral contusion based on the specific TBI coding in the provided data dictionary. In the original cohort study, each participating site's radiologist made the determination as to the presence or absence of TBI on CT and the specific finding. Local radiologists were asked to reread CTs with unclear findings to attempt to make a definitive read. The local radiologists received no prior definitions or guidance regarding the definition of what constituted a cerebral contusion. If still equivocal after local read, the CT scans were adjudicated centrally by a lead study radiologist.[11] For the present study, we only used the CT reports in the database; no CTs were available to obtain further clarification of findings because the data were solely from a deidentified database.

We defined *patients with isolated cerebral contusions* as those with none of the following additional findings on CT: intraventricular hemorrhage, intracranial hemorrhage, cerebral edema, traumatic infarction, diffuse axonal injury, shearing injury, sigmoid sinus thrombus, midline shift, signs of brain herniation, diastasis of the skull, pneumocephalus, depressed skull fracture, or basilar skull fracture. Because nondepressed linear skull fractures rarely require further intervention, we categorized patients with cerebral contusions and linear skull fractures as having isolated cerebral contusions.[12] We reviewed the radiologic impressions of all patients who had both cerebral contusions and skull fractures (available in the public data set) to determine if any skull fractures were depressed. If we were unable to determine whether the fracture was depressed, we categorized the patient as having a nonisolated cerebral contusion. Patients with skull fractures whose radiologic impressions were missing from the data set were excluded from further analysis. We further reviewed the radiologic impressions of all patients with isolated cerebral contusions to determine the sizes and locations of the cerebral contusions. We categorized the location of cerebral contusions based on the lobe(s) involved as frontal, parietal, temporal, occipital, or multiple. Patients with cerebral contusions present in either two or more different lobes or bilaterally (i.e., the left and the right parietal lobes) were grouped into the "multiple cerebral contusions" category.

Finally, similar to the process previously detailed, we reviewed the radiology reports of all those in the public use data set who met the inclusion and exclusion criteria but had isolated intracranial hemorrhages on CT. We did so to identify whether some cerebral contusions were coded as intracranial hemorrhages and, if so, to assess for acute adverse outcomes in these patients.

Acute Adverse Outcomes

We defined acute adverse outcomes as any of the following: death due to TBI, neurosurgery for TBI, or intubation for 24 hours or longer for the head trauma.[11]

Statistical Analysis

We summarized all data using standard descriptive statistics. All analyses were conducted with SPSS (version 21, IBM Corp., Armonk, NY).

RESULTS

A total of 43,904 patients were enrolled in the parent study. Of those 14,983 with GCS scores of 14 or 15 included in the present analysis, cerebral contusions were present on 152 CTs (1.0%; 95% confidence interval [95% CI], 0.8–1.2%) (Fig. 1). We excluded one patient with missing data who had a cerebral contusion and skull fracture. Of the 151 patients with cerebral contusions who had complete data, 54 patients had isolated cerebral contusions (35.8%; 95% CI, 28.0–43.5%), including 39 (72.2%) without and 15 (27.8%) with associated nondepressed linear skull fractures.

Table 1 displays the characteristics of children with isolated cerebral contusions. The median age was 9 years (interquartile range, 1–13 years), and 72.2% were male. Of the 54 with isolated cerebral contusions, 48 (88.9%) had GCS scores of 15 and 31 patients (57.4%) had both GCS scores of 15 and no other signs of altered mental status.

The radiologic impressions of 36 (66.7%) patients with isolated cerebral contusions included data regarding the size of the contusion. Of these cerebral contusions, 34 (94.4%) were described as "tiny," "subtle," "small," "very small," "punctate," or "minimal." Only two cerebral contusions were specifically measured, one measured to be 5×8 mm and the other 2×2 mm. Of the 45 patients with data available on cerebral contusion location, 17 cerebral contusions (37.8%) were solely in the frontal lobe, 6 (13.3%) only in the parietal lobe, 7 (15.6%) solely in the temporal lobe, 0 in the occipital lobe alone, and 15 (33.3%) had contusions in multiple locations (i.e., in same or more than one lobe).

No acute adverse outcomes occurred in those with isolated cerebral contusions. No patient died, required neurosurgery, or was intubated longer than 24 hours for TBI (95% CI, 0–6.6%). Of the 54 patients with isolated cerebral

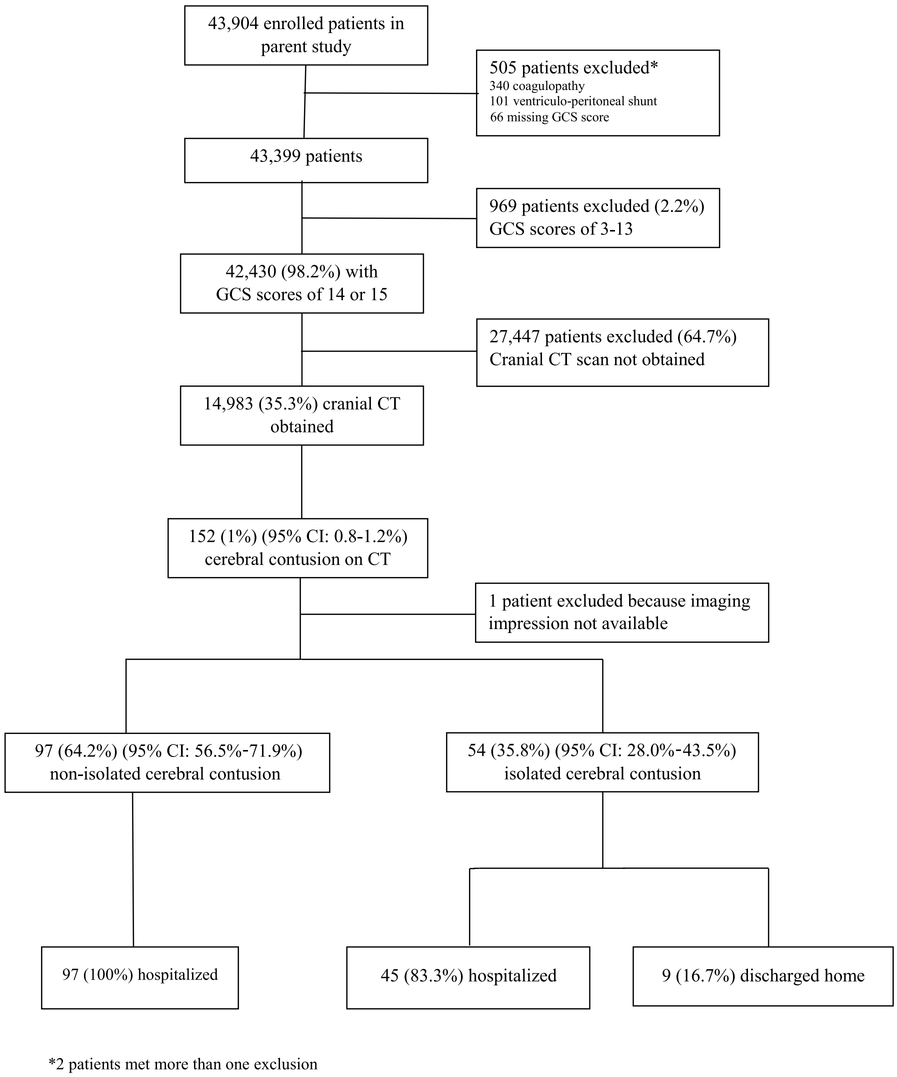

Figure 1. Subject flowchart.

contusions, 45 (83.3%) were hospitalized, including 18 (33.3%) who were hospitalized for two nights or more and 16 (29.6%) who were admitted to the ICU.

To identify if there were other patients with isolated cerebral contusions in the data set, we reviewed the available data for 40 patients found to have isolated intracranial hemorrhages; four of these patients had CT reports that noted "hemorrhagic contusions" or included both contusion and hemorrhage in the descriptions. All four of the patients with contusions in the reports had GCS scores of 15, although two had other signs of altered mental status. None of the four patients died, was intubated longer than 24 hours, or required neurosurgery.

DISCUSSION

We found cerebral contusions to be uncommon in children with minor blunt head trauma. Most patients with cerebral contusions had other intracranial injuries. The majority of patients with isolated cerebral contusions had small contusions, and most of these children presented to the ED with normal mental status. Of importance, no patient with isolated cerebral contusions had acute adverse outcomes, including none who required neurosurgery. Despite this, many patients were admitted to the ICU.

Previous studies of patients with cerebral contusions have generally been in adults and not focused on the subgroup with minor trauma, which likely accounts for the higher risk of associated intracranial bleeding and clinical symptoms and signs noted in the literature.[6–9] Previous research also suggests that patients with larger cerebral contusions (e.g., >3 cm), bilateral cerebral contusions (e.g., bifrontal), and those having other intracranial bleeding (e.g., subdural hematomas) have a substantial likelihood of undergoing neurosurgery or having an adverse outcome.[6–9,13] Clearly, the sample in the present study represents a population with more modest CT findings (e.g., small isolated cerebral contusions) and would be expected to have fewer adverse outcomes. In one previous study of adults, it was noted that no patient with cerebral contusions and a GCS score of 15 needed delayed neurosurgical evacuation.[6]

TABLE 1. Characteristics of Patients With Isolated Cerebral Contusions

	Isolated Cerebral Contusions (N = 54)
Median age, y	9 (1–13)
Age < 2 y	16 (29.6)
Male	39 (72.2)
Race (n = 54)	
White	37 (68.5)
Black	13 (24.1)
Asian	1 (1.8)
Pacific Islander	0 (0)
Missing or other	3 (5.6)
Mechanism of injury (n = 54)	
Fall from elevation	13 (24.1)
Sports	8 (14.8)
Occupant in motor vehicle crash	7 (13.0)
Fall down stairs	6 (11.1)
Other wheeled transport crash	5 (9.3)
Object struck head	4 (7.4)
Fall from standing	3 (5.6)
Other	2 (3.7)
Pedestrian struck by motor vehicle	2 (3.7)
Bicycle struck by motor vehicle	1 (1.8)
Bicycle collision	1 (1.8)
Assault	1 (1.8)
Missing	1 (1.8)
Abnormal mental status*	23 (42.6)
GCS score 14 but no other signs of altered mental status	1 (4.4)
Other signs of altered mental status but GCS score 15	17 (73.9)
GCS score 14 and other signs of altered mental status	5 (21.7)
Neurologic deficit (not included mental status)	0 (0)
History of loss of consciousness (n = 47)	16 (29.6)
History of vomiting	15 (27.8)

*Defined as a GCS score of 14 or other signs of altered mental status (agitation, sleepiness, slowness to respond to questioning, or asking repetitive questions).
Values are presented as median (interquartile range) or n (%).

Certain limitations were present in the current study. Computed tomography scans were not performed on all children in the cohort, which potentially impacted the overall prevalence of cerebral contusions noted. Computed tomography was not uniformly reviewed by a central study radiologist, although local CT rereads were completed for more subtle or unclear findings and central radiologist rereads were completed with equivocal local reads. In addition, the public use database did not provide extensive details of the clinical course of hospitalized patients, such as whether they were ever intubated, the results of subsequent CTs (if performed), and any change in clinical status. Therefore, we cannot comment on the clinical course regarding patients' signs and symptoms, some interventions, or the progression of intracranial bleeding on CT. However, no patient died, required neurosurgery, or was intubated longer than 24 hours. We do not have details on more subacute or chronic outcomes. The database also does not provide extensive details of cerebral contusion size; the majority of patients in the sample had small contusions. The conclusions of our study, therefore, should not be extrapolated to patients with larger cerebral contusions or those who do not meet the definition we used for minor blunt head trauma. Finally, the study includes a relatively small sample with isolated cerebral contusions, although the largest of which we are aware.

In conclusion, children with GCS scores of 14 or 15 after minor blunt head trauma and small isolated cerebral contusions on CT are unlikely to require acute interventions, including neurosurgery, suggesting that neither ICU admission nor prolonged hospitalization is generally required. Further study is needed to determine the outcomes of children with larger isolated cerebral contusions.

AUTHORSHIP

P.V. designed the study, performed the analysis, interpreted the results, and wrote or revised the manuscript. K.C. performed the literature review, interpreted the results, and wrote or revised the manuscript. N.K. interpreted the results and edited and revised the manuscript. P.D. designed the study, supervised the study and data analysis, interpreted the results, and edited and revised the manuscript.

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DISCLOSURE

The authors declare no conflicts of interest.

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