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ORIGINAL CONTRIBUTION

Relationship of Physician-identified Patient Race and Ethnicity to Use of Computed Tomography in Pediatric Blunt Torso Trauma

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Abstract

Objectives: The objective was to determine whether a child's race or ethnicity as determined by the treating physician is independently associated with receiving abdominal computed tomography (CT) after blunt torso trauma.

Methods: We performed a planned secondary analysis of a prospective observational cohort of children < 18 years old presenting within 24 hours of blunt torso trauma to 20 North American emergency departments (EDs) participating in a pediatric research network, 2007–2010. Treating physicians documented race/ethnicity as white non-Hispanic, black non-Hispanic, or Hispanic. Using a previously derived clinical prediction rule, we classified each child's risk for having an intra-abdominal injury undergoing acute intervention to define injury severity. We performed multivariable analyses using generalized estimating equations to control for confounding and for clustering of children within hospitals.

Results: Among 12,044 enrolled patients, treating physicians documented race/ethnicity as white non-Hispanic (n = 5,847, 54.0%), black non-Hispanic (n = 3,687, 34.1%), or Hispanic of any race (n = 1,291, 11.9%). Overall, 51.8% of white non-Hispanic, 32.7% of black non-Hispanic, and 44.2% of Hispanic children underwent abdominal CT imaging. After age, sex, abdominal ultrasound use, risk for intra-abdominal injury undergoing acute intervention, and hospital clustering were adjusted for, the likelihood of receiving an abdominal CT was lower (odds ratio [OR] = 0.8, 95% confidence interval [CI] = 0.7 to 0.9) for black non-Hispanic than for white non-Hispanic children. For Hispanic children, the likelihood of receiving an abdominal CT did not differ from that observed in white non-Hispanic children (OR = 0.9, 95% CI = 0.8 to 1.1).

Conclusions: After blunt torso trauma, pediatric patients identified by the treating physicians as black non-Hispanic were less likely to receive abdominal CT imaging than those identified as white non-Hispanic. This suggests that nonclinical factors influence clinician decision-making regarding use of

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abdominal CT in children. Further studies should focus on explaining how patient race can affect provider choices regarding ED radiographic imaging.

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There is continuing evidence of racial and ethnic disparities in children's access to and use of medical services,[1,2] as well as in selected health outcomes.[3] Perhaps most concerning, it appears that aspects of clinical management are differentially provided to children of different races, including in the emergency department (ED). For example, a recent report based on claims data from two large urban pediatric EDs revealed less frequent use of laboratory and radiologic testing in black children when compared to white non-Hispanic children, an effect that was also observed in a biracial group.[4] Another study analyzing data from the National Hospital Ambulatory Medical Care Survey suggested that black children were half as likely to receive computed tomography (CT) as part of their ED evaluation for abdominal pain.[5] Similarly, analysis of electronic medical record data from a single pediatric ED revealed differences based on race in the use of CT scanning, ultrasonography, provision of intravenous fluids, administration of narcotic analgesia, hospital admission, and surgery for children presenting with acute abdominal pain.[6]

Injury is the leading cause of both pediatric morbidity and mortality.[7] Among pediatric patients, trauma-associated mortality is infrequent but overall higher in both black and Hispanic patients.[8] Clinical management in the ED is particularly crucial in response to pediatric trauma. Our group has focused on understanding whether race and ethnicity influence clinician behavior in this context. Members of our group previously reported that cranial CT scans for the evaluation of children with minor blunt head trauma were less frequently ordered among patients whom clinicians identified as being other than white non-Hispanic.[9] The objective of the current study was to determine if the use of abdominal CT scans for the evaluation of blunt torso trauma in children is independently associated with patient race and ethnicity as identified by treating physicians.

METHODS

Study Design

We performed a planned secondary analysis of a large prospective observational cohort study of children younger than 18 years of age with blunt torso trauma. The primary study was conducted in the EDs at 20 Pediatric Emergency Care Applied Research Network (PECARN) sites between May 2007 and January 2010.[10] Participating hospitals are listed in the Appendix A. The primary study was reviewed and approved by the institutional review board at each site and informed consent was waived at all but one site. The methods of the primary study are described fully elsewhere,[10] while specific methods relevant to this secondary analysis are described below.

Study Setting and Population

For the parent study, inclusion criteria included any one of the following: 1) decreased level of consciousness in association with blunt torso trauma; 2) blunt traumatic event with either paralysis or multiple nonadjacent long bone fractures; 3) blunt torso trauma due to any of the following injury mechanisms: high-speed, ejection or rollover motor vehicle crash, fall 20 feet or more, crush injury to torso, or physical assault involving the abdomen; or 4) physician concern for abdominal trauma resulting in any of the following diagnostic tests: abdominal CT, abdominal ultrasound including focused assessment with sonography for trauma, laboratory testing to screen for intra-abdominal injury, and chest or pelvic radiography. Patients were excluded if the injury occurred greater than 24 hours before presentation or was penetrating. Additionally, patients were excluded if they had a preexisting neurologic disorder restricting dependable examination, were known to be pregnant, or were transferred from another hospital with previous abdominal CT or diagnostic peritoneal lavage.

Measures

The treating physician completed and documented a structured patient history and physical examination before obtaining a CT scan (if performed). The decision to obtain an abdominal CT scan was at discretion of the treating physician. Additionally, whether a CT was obtained or not, the treating physician recorded their clinical suspicion for: 1) the presence of an intra-abdominal injury identifiable on CT and 2) an intra-abdominal injury that would require acute intervention. Additional information on the study population, methods, interobserver agreement, and outcomes of children discharged from the ED without CT scans are reported in other study publications.[10,11]

In addition, the treating physician determined and recorded the patient's ethnicity (Hispanic/Latino, non-Hispanic/Latino, or unknown) and race (American Indian/Alaskan Native, Asian, black/African American, Pacific Islander, white, unknown, or other). In the secondary analysis reported here, race and ethnicity were categorized as follows. Ethnicities listed as non-Hispanic or unknown were treated as non-Hispanic. Race and ethnicity were divided into three main categories: white non-Hispanic, black non-Hispanic, and Hispanic of any race. Children identified by physician as unknown race and with ethnicity as non-Hispanic or unknown (n = 780) were excluded from the analysis. In addition, we excluded patients with race and ethnicity different than these three main categories (such as Pacific Islander) due to insufficient sample size (*n* = 439).

The previously derived PECARN clinical prediction rules for intra-abdominal injury undergoing acute intervention identified four risk levels: high, moderate, low, and very low (Table 1).[10] In the secondary analysis reported here, we used this clinical prediction rule four-level risk classification to classify each child's risk for an intra-abdominal injury undergoing an acute intervention. Because preliminary analyses demonstrated similar outcomes in moderate- and high-risk levels, we combined these risk categories for this analysis.

Data Analysis

We described categorical data using counts, percentages, and 95% confidence intervals (CI) where appropriate, while continuous data were described using the median and interquartile range (IQR [25th–75th percentile]). We defined the outcome of interest as whether an abdominal CT was obtained in the ED. We calculated rates of children undergoing abdominal CT for each of the three race and ethnicity groups by age, sex, Glasgow Coma Scale (GCS) score, risk for an intra-abdominal injury undergoing acute intervention, and clinical suspicion for intra-abdominal injury undergoing acute intervention. We used a chi-square test of independence for each comparison of the race and ethnicity groups. We employed standard multivariable logistic modeling to estimate the associations between abdominal CT rates and race and ethnicity, controlling for age, sex, abdominal ultrasound use in ED, and risk for an intra-abdominal injury undergoing acute intervention based on the PECARN prediction rule. We selected covariates from the PECARN prediction rule as well as important demographic and clinical variables.[10] It should be noted that all covariates are categorical. We tested for influential data points and potential outliers, and all analyses revealed no observations potentially negatively influencing the results of the model. Applying standard covariate rules, our model had 670 CT scans obtained per variable explored.[12] We used generalized estimating equations (GEE) to account for the clustering of children within hospitals. To select the best-fit model, we calculated the Quasilikelihood under the Independence model Criterion (QICu) statistic[13,14] for each model. Then we compared the QICu of all GEE models containing all combinations of these variables including first-order interactions. We present the results from the model with race and ethnicity, age, sex, abdominal ultrasound use in ED, and risk for an intra-abdominal injury undergoing acute intervention because its QICu was lower than the QICu for all other models. Physician clinical suspicion for intra-abdominal injury undergoing acute intervention was not included in the model as it was strongly associated with risk for an intra-abdominal injury undergoing acute intervention. GCS was not included in the model because it is part of the model for risk for intra-abdominal injury undergoing acute intervention. Data analysis was performed with SAS version 9.3 (SAS Institute). The funding agencies had no role in the conduct or reporting of the study.

Table 1
Risk Stratification Criteria Among Patients With Blunt Torso Trauma

PECARN Rule Risk Level for IAI Undergoing Intervention	Risk of IAI Undergoing Intervention	Clinical Criteria
High	5.4%	Evidence of abdominal wall trauma/seat belt sign or GCS score < 14 with blunt abdominal trauma
Moderate	1.4%	Abdominal tenderness without criteria for high risk level
Low	0.7%	Thoracic wall trauma, complaints of abdominal pain, decreased breath sounds, or vomiting without criteria for moderate or high risk level
Very low	0.1%	Without criteria for low, moderate, or high risk level

Modified from Holmes et al.[10]
GCS = Glasgow Coma Scale; IAI = intra-abdominal injury; PECARN = Pediatric Emergency Care Applied Research Network.

RESULTS

Characteristics of Study Subjects

The primary study enrolled 12,044 (80.9%) of 14,882 eligible patients. Among these, per designation by the treating physician, 10,825 (89.9%) had race/ethnicity identified as white non-Hispanic (*n* = 5,847, 54.0%), black non-Hispanic (*n* = 3,687, 34.1%), or Hispanic of any race (*n* = 1,291, 11.9%). Evaluated children had a median (IQR) age of 11.3 (6.0 to 15.1) years and 61.5% were male (Table 2). Overall, 4,803 (44.4%) patients received an abdominal CT scan with rates of 51.8, 32.7, and 44.2%, respectively, for white non-Hispanic, black non-Hispanic, and Hispanic groups (Table 2).

Main Results

With the exception of children presenting with GCS scores of 14 and those with clinical suspicion for intra-abdominal injury undergoing acute intervention greater than 10%, children identified as white non-Hispanic by the treating physician were more likely to receive abdominal CT scans than black non-Hispanic children (Table 3). Similarly, white non-Hispanic children were generally more likely to receive abdominal CT scans than Hispanic children, although comparisons between these two groups were statistically significant in fewer comparison categories. Comparable to the white, non-Hispanic group, Hispanic children were more likely than black non-Hispanic children to receive abdominal CT scans, except for children presenting with GCS scores of 14 and those with clinical suspicion for intra-abdominal injury undergoing acute intervention greater than 5%.

Multivariable analyses (Table 4) revealed that children identified by the treating physician as black non-Hispanic were less likely to receive abdominal CT scans ordered by those same physicians (odds ratio

Table 2
Patient Characteristics by Provider-determined Patient Race and Ethnicity

Variable	Entire Group (n = 10,825)	Race/Ethnicity: White Non-Hispanic (n = 5847)	Black Non-Hispanic (n = 3687)	Hispanic (n = 1291)
Age (y), median (IQR)	11.3 (6.0–15.1)	11.7 (6.4–15.3)	10.9 (6.1–14.9)	9.9 (4.4–14.7)
Age ≥ 2 y, %	90.8	91.2	90.9	88.2
Male, %	61.5	62.5	60.0	61.3
GCS 15, %	86.8	86.1	88.7	84.0
Ultrasound performed in ED, %*	9.1	9.8	6.5	13.1
Risk for IAI undergoing intervention, %				
Low	42.1	36.5	51.3	41.2
Mild	14.2	15.3	12.4	14.3
Moderate/high	43.7	48.1	36.3	44.5
ED disposition to home, %	50.6	45.6	58.6	50.7
Abdominal CT in ED, %	44.4	51.8	32.7	44.2
Rate of IAI on CT, %	12.4	13.6	10.3	10.4

CT = computed tomography; GCS = Glasgow Coma Scale; IAI = intra-abdominal injury; IQR = interquartile range; y = years.
*For ultrasound performed in ED, overall n = 10,642, white non-Hispanic n = 5,745, black non-Hispanic n = 3,632, and Hispanic n = 1,265.

Table 3
Percentage of Children Receiving Abdominal CT by Race/Ethnicity, Age, Sex, Injury Severity, and Provider Suspicion for IAI Undergoing Intervention

Variable	Children, % (95% CI): White Non-Hispanic (n = 5,847)	Black Non-Hispanic (n = 3,687)	Hispanic (n = 1,291)
Age group, y			
<2*‡	35.6 (31.5–39.9)	27.2 (22.5–32.4)	40.1 (32.3–48.4)
≥2*†‡	53.3 (52.0–54.7)	33.3 (31.7–34.9)	44.7 (41.8–47.6)
Sex			
Male*†‡	52.2 (50.6–53.9)	33.1 (31.2–35.1)	45.2 (41.7–48.7)
Female*†‡	51.0 (48.9–53.1)	32.1 (29.7–34.5)	42.5 (38.1–47.0)
GCS score			
14	58.1 (52.2–63.7)	51.1 (43.7–58.5)	51.1 (40.5–61.5)
15*†‡	48.8 (47.4–50.2)	29.4 (27.9–31.0)	40.6 (37.6–43.5)
Risk for IAI undergoing intervention			
Low*†‡	29.5 (27.6–31.5)	17.1 (15.5–18.9)	25.0 (21.4–28.9)
Mild*‡	31.9 (28.9–35.1)	21.9 (18.2–26.0)	34.6 (27.8–41.9)
Moderate/high*†‡	75.0 (73.3–76.6)	58.4 (55.8–61.1)	65.0 (60.9–68.9)
Clinical suspicion for IAI undergoing acute intervention			
<1%*†‡	39.0 (37.5–40.4)	23.0 (21.5–24.5)	32.4 (29.5–35.4)
1%–5%*‡	86.0 (83.7–88.2)	75.2 (70.8–79.3)	85.9 (80.0–90.6)
6–10%*	95.3 (92.1–97.5)	89.5 (82.3–94.4)	91.4 (81.0–97.1)
>10%	92.3 (87.8–95.5)	95.5 (88.9–98.8)	91.2 (76.3–98.1)

CT = computed tomography; GCS = Glasgow Coma Scale; IAI = intra-abdominal injury; y = years.
*$p < 0.05$ for white non-Hispanic versus black non-Hispanic comparisons.
†$p < 0.05$ for white non-Hispanic versus Hispanic comparisons.
‡$p < 0.05$ for black non-Hispanic versus Hispanic comparisons.

[OR] = 0.8, 95% CI = 0.7 to 0.9) than white non-Hispanic children. The likelihood of receiving an abdominal CT in Hispanic children did not differ from that observed in white non-Hispanic children (OR = 0.9, 95% CI = 0.8 to 1.1).

DISCUSSION

We conducted a planned secondary analysis of data from 20 hospitals describing ED use of abdominal CT in children with blunt torso trauma.[10] With a large sample size, both bivariable and adjusted analyses revealed that white non-Hispanic children were more likely than black children to be evaluated with abdominal CT scans. This work extends and complements research focused on the relationship of race/ethnicity to the ED evaluation of abdominal pain in pediatric patients[3,5,6,15] by focusing on the more urgent problem of abdominal injury and use of prospectively collected information, clearly identified inclusion and exclusion criteria, and protocol-driven data collection methods. The purpose of the analyses reported here was to assess whether

Table 4
Relationship of Physician-identified Patient Race and Ethnicity to Use of CT in Pediatric Blunt Torso Trauma: Results of GEE, Adjusted for Age Group, Sex, Ultrasound Performed in ED, and Risk (PECARN Rule Calculated) for IAI Undergoing Intervention

Variable	Adjusted OR (95% CI)
Race/ethnicity	
White non-Hispanic	1 [reference]
Black non-Hispanic	0.8 (0.7–0.9)
Hispanic	0.9 (0.8–1.1)
Age group (≥2 y)	1.0 (0.9–1.2)
Sex (male)	1.1 (1.02–1.2)
Ultrasound performed in ED	1.4 (1.1–1.7)
Risk for IAI intervention	
Low	1 [reference]
Mild	1.2 (1.1–1.4)
Moderate/High	6.1 (4.7–7.9)

CT = computed tomography; GEE = generalized estimating equations; IAI = intra-abdominal injury; PECARN = Pediatric Emergency Care Applied Research Network; y = years.

patient race/ethnicity, as determined by the treating physician, was linked to clinical decision-making regarding CT use. Importantly, clinicians responsible for ordering CTs in this study were also those responsible for identifying and recording the race/ethnicity of each patient.

Because injury is the leading cause of pediatric morbidity and mortality and its early management in the ED requires meticulous and objective evaluation, racial/ethnic disparities in diagnostic interventions continue to be troubling. Race and ethnicity appear to influence the likelihood of mortality in adult trauma patients,[16–18] perhaps partially explained by the clustering of minority trauma patients at trauma centers with worse than expected mortality[19] and/or differences in management.[20–22] Among pediatric patients, trauma-associated mortality overall is infrequent, but multivariable analyses of the National Trauma Data Bank reveal that it is higher in both black and Hispanic patients.[8] In contrast to national data, trauma mortality was not related to race/ethnicity in an analysis of administrative data from California,[23] perhaps due to state efforts to provide insurance coverage for children and an emphasis on culturally competent care. Regardless of the effects of trauma care on mortality, equity in provision of pediatric care remains an important priority,[24] and data reported here raise concerns regarding equitable use of CT evaluation in pediatric patients who have experienced torso trauma.

Our study results are generally consistent with the observation of racial disparities in ordering radiologic and laboratory tests for pediatric ED patients,[4] including those presenting with chest pain where white pediatric patients were more likely than minority patients to receive testing despite similar demographic characteristics and illness severity.[25] Our findings are also consistent with several reports of racial disparities in the evaluation of abdominal complaints.[5,15] Whether positive or negative, investigations of potential disparities require careful attention to methods for assigning patients to racial and ethnic categories. Racial and ethnic data analyzed as part of the current study were determined and recorded by treating physicians, thereby assuring that these patient descriptors corresponded to the impressions of those making clinical management decisions regarding imaging.

There are a variety of possible explanations for the observed disparity in the use of abdominal CT in pediatric trauma patients. Each requires careful consideration. First, it is possible that injury severity varies by race and ethnicity, thereby warranting differential use of imaging modalities. In the analyses reported here, we validly assessed risk of an intra-abdominal injury serious enough to undergo an acute intervention as documented in specific elements of the history and physical examination.[10] Therefore, racial and ethnic differences in injury severity are unlikely to account for observed differences in CT use. Second, there may be interinstitutional differences in patient management, creating apparent racial disparities if the distribution of race and ethnicity also varies between institutions. We used multivariable analyses adjusted for site differences using GEEs to account for such clustering, making it unlikely that the reported findings arise from such confounding. Finally, it is conceivable that there are true differences in diagnostic practices for pediatric patients presenting with blunt torso trauma. If this is the case, the influence of nonclinical factors on physician decision-making, such as implicit bias,[26] clearly requires careful further appraisal. In evaluating this possibility, it is provocative to note that at the highest levels of clinical risk, the racial disparity in CT use is no longer observed. Thus, whatever influences are leading to the detected disparity are apparently overcome as clinical factors assume greater importance in those patients with more serious injuries.

It is plausible that the results reported here reflect overuse in white non-Hispanic children rather than underuse in other racial/ethnic groups. Previous work by members of our group and others demonstrate that selected ED interventions, notably hospital admissions[27] and use of cranial CT for minor head trauma,[9] may actually reflect the overuse in white non-Hispanic children. The latter is particularly intriguing as there are documented risks of future cancer in children exposed to ionizing radiation from CT imaging.[28–31] Regardless of whether risk for intra-abdominal injury undergoing intervention was defined using risk stratification by the PECARN prediction rule or by clinician suspicion, abdominal CT rates were highest in the white non-Hispanic white children. As children at such a low risk are highly unlikely to benefit from abdominal CT scanning, this finding supports the concept that abdominal CT is overused more commonly in white non-Hispanic children with blunt torso trauma.

Although the reason for overuse is not clear, in our prior study on cranial CT use in children with minor blunt head trauma, parental request was an important indicator for CT use in the lowest-risk patients and was more commonly cited in white non-Hispanic children.[9] Here, parental request for CT scanning after blunt torso trauma was the documented reason for CT scanning in only two patients, suggesting that parental request played little role in the decision to obtain abdominal CT scanning. However, neither this nor the head trauma study was designed to definitely identify factors influencing the decision for CT evaluation in each patient.

LIMITATIONS

We recognize that the current study has certain limitations that need to be considered. Most importantly, neither insurance status nor parental socioeconomic status was documented; therefore, we are unable to describe the relationship of race and ethnicity to abdominal CT use independent of these covariates. However, the focus of our analysis was based on the physician impression of race and ethnicity, and insurance status is not commonly known by emergency physicians caring for trauma patients. The fact that we classified children with unknown ethnicity as non-Hispanic may have resulted in some misclassification, thereby creating a conservative bias and reducing differences between Hispanics and non-Hispanics. In addition, 6.5% of otherwise eligible children were excluded because information regarding race and/or ethnicity was not sufficiently complete. This creates a potential bias should these children have been treated in ways systematically different from children whose data were analyzed. However, this relatively small proportion of patients would be unlikely to change the major conclusions on this study. Further, it can also be asked whether disparities observed here are widely reflective of practice patterns in the emergency evaluation of pediatric trauma patients. Our analyses of race/ethnicity and abdominal CTs including 10,825 pediatric patients obtained prospectively over nearly 3 years from 20 participating institutions provides a broad sampling and detailed evaluation of pediatric emergency trauma care. Nonetheless, we are aware that institutions choosing to participate in this study may not be generally representative of all EDs evaluating pediatric trauma patients. Yet, it is likely that any bias introduced by such self-selection would diminish rather than inflate the estimated association between race and CT use based on the assumed emphasis on quality and protocolized care in participating institutions. Finally, we evaluated patient risk for intra-abdominal injury undergoing acute intervention based on the PECARN clinical prediction rule rather than based on clinician suspicion, due to the substantial collinearity in these variables. We have a primary interest in the value of empirically derived risk stratification algorithms and therefore used the calculated risk rather than perceived risk as the basis for our analyses and report. Substituting clinical suspicion for the risk derived from the PECARN prediction rule model, however, provides similar results (data not shown).

CONCLUSIONS

In summary, after blunt torso trauma, non-Hispanic black children are less likely to receive abdominal computed tomography imaging than white non-Hispanic children. This finding suggests that nonclinical factors may influence clinician decision-making regarding use of abdominal computed tomography after trauma in children. Further studies should focus on explaining how factors such as patient race or ethnicity can affect provider decision-making regarding ED radiographic imaging and on developing effective approaches to overcoming such concerning disparities to ensure the highest-quality and equitable care for all children. Individual clinicians may consider the recent recommendations of Cheng et al.[32] and complete free online assessments of implicit social cognition leading to conscious or unconscious biases that may influence their practice patterns (https://implicit.harvard.edu/implicit).[33]

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References

1. Flores G, Rabke-Verani J, Pine W, Sabharwal A. The importance of cultural and linguistic issues in the emergency care of children. Pediatr Emerg Care 2002;18:271–84.
2. Gerber JS, Prasad PA, Localio AR, et al. Racial differences in antibiotic prescribing by primary care pediatricians. Pediatrics 2013;131:677–84.
3. Ponsky TA, Huang ZJ, Kittle K, et al. Hospital- and patient-level characteristics and the risk of appendiceal rupture and negative appendectomy in children. JAMA 2004;292:1977–82.
4. Payne NR, Puumala SE. Racial disparities in ordering laboratory and radiology tests for pediatric patients in the emergency department. Pediatr Emerg Care 2013;29:598–606.
5. Fahimi J, Herring A, Harries A, Gonzales R, Alter H. Computed tomography use among children presenting to emergency departments with abdominal pain. Pediatrics 2012;130:e1069–75.
6. Caperell K, Pitetti R, Cross KP. Race and acute abdominal pain in a pediatric emergency department. Pediatrics 2013;131:1098–106.
7. Borse NN, Gilchrist J, Dellinger AM, Rudd RA, Ballesteros MF, Sleet DA. Unintentional childhood injuries in the United States: key findings from the CDC childhood injury report. J Safety Res 2009;40:71–4.
8. Rosen H, Saleh F, Lipsitz SR, Meara JG, Rogers SO Jr. Lack of insurance negatively affects trauma mortality in US children. J Pediatr Surg 2009;44:1952–7.
9. Natale JE, Joseph JG, Rogers AJ, et al. Cranial computed tomography use among children with minor blunt head trauma: association with race/ethnicity. Arch Pediatr Adolesc Med 2012;166:732–7.
10. Holmes JF, Lillis K, Monroe D, et al. Identifying children at very low risk of clinically important blunt abdominal injuries. Ann Emerg Med 2013;62:107–16.
11. Yen K, Kuppermann N, Lillis K, et al. Interobserver agreement in the clinical assessment of children with blunt abdominal trauma. Acad Emerg Med 2013;20:426–32.
12. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol 1996;49:1373–9.
13. Pan W. Akaike's information criterion in generalized estimating equations. Biometrics 2001;57:120–5.

14. Hardin JW, Hilbe JM. Generalized Estimating Equations. New York: Chapman & Hall/CRC, 2003.
15. Johnson TJ, Weaver MD, Borrero S, et al. Association of race and ethnicity with management of abdominal pain in the emergency department. Pediatrics 2013;132:e851–8.
16. Arthur M, Hedges JR, Newgard CD, Diggs BS, Mullins RJ. Racial disparities in mortality among adults hospitalized after injury. Med Care 2008;46:192–9.
17. Crompton JG, Pollack KM, Oyetunji T, et al. Racial disparities in motorcycle-related mortality: an analysis of the National Trauma Data Bank. Am J Surg 2010;200:191–6.
18. Maybury RS, Bolorunduro OB, Villegas C, et al. Pedestrians struck by motor vehicles further worsen race- and insurance-based disparities in trauma outcomes: the case for inner-city pedestrian injury prevention programs. Surgery 2010;148:202–8.
19. Haider AH, Hashmi ZG, Zafar SN, et al. Minority trauma patients tend to cluster at trauma centers with worse-than-expected mortality: can this phenomenon help explain racial disparities in trauma outcomes? Ann Surg 2013;258:572–9; discussion 9–81.
20. Bolorunduro OB, Haider AH, Oyetunji TA, et al. Disparities in trauma care: are fewer diagnostic tests conducted for uninsured patients with pelvic fracture? Am J Surg 2013;205:365–70.
21. Millham F, Jain NB. Are there racial disparities in trauma care? World J Surg 2009;33:23–33.
22. Shafi S, Gentilello LM. Ethnic disparities in initial management of trauma patients in a nationwide sample of emergency department visits. Arch Surg 2008;143:1057–61; discussion 61.
23. Ramirez M, Chang DC, Bickler SW. Pediatric injury outcomes in racial/ethnic minorities in California: diversity may reduce disparity. JAMA Surg 2013;148:76–80.
24. Council on Community Pediatrics and Committee on Native American Child Health. Policy statement–health equity and children's rights. Pediatrics 2010;125:838–49.
25. Hambrook JT, Kimball TR, Khoury P, Cnota J. Disparities exist in the emergency department evaluation of pediatric chest pain. Congenit Heart Dis 2010;5:285–91.
26. Sabin J, Nosek BA, Greenwald A, Rivara FP. Physicians' implicit and explicit attitudes about race by MD race, ethnicity, and gender. J Health Care Poor Underserved 2009;20:896–913.
27. Chamberlain JM, Joseph JG, Patel KM, Pollack MM. Differences in severity-adjusted pediatric hospitalization rates are associated with race/ethnicity. Pediatrics 2007;119:e1319–24.
28. Brenner DJ, Hall EJ. Computed tomography–an increasing source of radiation exposure. N Engl J Med 2007;357:2277–84.
29. Mathews JD, Forsythe AV, Brady Z, et al. Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. BMJ 2013;346:f2360.
30. Miglioretti DL, Johnson E, Williams A, et al. The use of computed tomography in pediatrics and the associated radiation exposure and estimated cancer risk. JAMA Pediatr 2013;167:700–7.
31. Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. Lancet 2012;380:499–505.
32. Cheng TL, Emmanuel MA, Levy DJ, Jenkins RR. Child health disparities: what can a clinician do? Pediatrics 2015;136:961–8.
33. Project Implicit. 2011. Accessed Nov 14, 2015. Available at: https://implicit.harvard.edu/implicit/.

Appendix A

Participating centers and site investigators are listed below in alphabetical order: Bellevue Hospital Center (M. Tunik); Children's Hospital Boston (L. Lee); Children's Hospital of Michigan (P. Mahajan); Children's Hospital of New York–Presbyterian (M. Kwok); Children's Hospital of Philadelphia (F. Nadel); Children's National Medical Center (S. Atabaki); Cincinnati Children's Hospital Medical Center (B. Kerrey); DeVos Children's Hospital (J. Kooistra); Howard County Medical Center (D. Monroe); Hurley Medical Center (D. Borgialli); Jacobi Medical Center (S. Blumberg); Medical College of Wisconsin/Children's Hospital of Wisconsin (K. Yen); Nationwide Children's Hospital (B. Bonsu); University of California Davis Medical Center (N. Kuppermann, J. Holmes); University of Maryland (J. Menaker); University of Michigan (A. Rogers); University of Rochester (M. Garcia); University of Utah/Primary Children's Medical Center (K. Adelgais); Washington University/St. Louis Children's Hospital (K. Quayle); Women and Children's Hospital of Buffalo (K. Lillis).

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