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Racial and Ethnic Disparities and Bias in the Evaluation and Reporting of Abusive Head Trauma

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Abstract

Objective—To characterize racial and ethnic disparities in the evaluation and reporting of suspected abusive head trauma (AHT) across the 18 participating sites of the Pediatric Brain Injury Research Network (PediBIRN). We hypothesized that such disparities would be confirmed at multiple sites and occur more frequently in patients with a lower risk for AHT.

Study design—Aggregate and site-specific analysis of the cross-sectional PediBIRN dataset, comparing AHT evaluation and reporting frequencies in subpopulations of white/non-Hispanic and minority race/ethnicity patients with lower vs higher risk for AHT.

Results—In the PediBIRN study sample of 500 young, acutely head-injured patients hospitalized for intensive care, minority race/ethnicity patients (n = 229) were more frequently evaluated ($P < .001$; aOR, 2.2) and reported ($P = .001$; aOR, 1.9) for suspected AHT than white/non-Hispanic patients (n = 271). These disparities occurred almost exclusively in lower risk patients, including those ultimately categorized as non-AHT ($P = .001$ [aOR, 2.4] and $P = .003$ [aOR, 2.1]) or with an estimated AHT probability of ≤25% ($P < .001$ [aOR, 4.1] and $P < .001$ [aOR, 2.8]). Similar site-

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specific analyses revealed that these results reflected more extreme disparities at only 2 of 18 sites, and were not explained by local confounders.

Conclusion—Significant race/ethnicity-based disparities in AHT evaluation and reporting were observed at only 2 of 18 sites and occurred almost exclusively in lower risk patients. In the absence of local confounders, these disparities likely represent the impact of local physicians' implicit bias.

Since the publication of *To Err Is Human*,[1] multiple studies have demonstrated disparities in the evaluation, diagnosis, and treatment of a wide variety of medical conditions attributable to differences in patient race or ethnicity.[2–9] Several studies have shown that there are race/ethnicity-based inconsistencies in the evaluation and diagnosis of child physical abuse.[10–13] In a retrospective, single institutional study of 173 victims of pediatric abusive head trauma (AHT), Jenny et al found that young victims of AHT with less severe, nonspecific, clinical presentations (eg, vomiting, irritability) were more likely to be misdiagnosed on initial presentation if the child was from a white family.[10] Lane et al found that, in older children deemed to be at lower risk for physical abuse, skeletal surveys and reports to child protective services were more likely to occur in patients of minority race/ethnicity, even if the fracture was consistent with an accidental mechanism.[11,12] In a retrospective study of infants hospitalized with traumatic brain injury, Wood et al concluded that racial disparities in AHT evaluation and reporting existed across a wide network of 39 pediatric hospitals.[13]

Racial and ethnic biases are often implicit biases, meaning they are unknown and largely invisible to those who hold them. Implicit biases are, therefore, particularly challenging to overcome because they operate "behind the scenes." Clinicians must decide what conditions should be considered in their differential diagnosis based partially on a patient's risk profile. However, unconscious stereotypes can influence medical decision making by causing clinicians to make erroneous assumptions about a patient's risk profile.

In the evaluation of possible child physical abuse, important historical information may be lacking owing to a caregiver being deliberately misleading, a caregiver not knowing the actual circumstances leading to the presentation for care, and/or the patient being nonverbal. In the absence of full or accurate historical data, clinicians may inadvertently allow their implicit biases to enter into their assessments of risk and decision making. This factor has the potential to lead to both overdiagnosis and underdiagnosis of physical abuse and other medical conditions.

From 2010 to 2013, the Pediatric Brain Injury Research Network (PediBIRN) investigators conducted sequential, multicenter, strictly observational, cross-sectional studies to derive and validate a clinical prediction rule that facilitates patient-specific estimation of AHT probability based on different combinations of its 4 predictor variables.[14,15] This effort required the capture of extensive, prospective, demographic, clinical, historical, and radiologic data regarding 500 acutely head-injured children <3 years of age hospitalized for intensive care across 18 participating sites.

In this article, we present the results of a novel, secondary analysis of the PediBIRN dataset designed to characterize racial/ethnic disparities in the evaluation and reporting of suspected

AHT. We hypothesized that such disparities would be verified at multiple individual sites and occur more frequently in patients with lower, patient-specific estimates of AHT probability.

Methods

This retrospectively designed, secondary analysis used de-identified data captured prospectively by PediBIRN investigators with detailed methods described previously.[14,15] All 18 participating sites obtained approval for the 2 parent studies with a waiver of informed consent from their local institutional review board. This secondary analysis was determined to be exempt from review by the Institutional Review Board at Penn State Health Hershey Medical Center.

In both parent studies[14,15] and at every participating site, (1) eligible patients were children <3 years of age hospitalized acutely in a pediatric intensive care unit (PICU) for the treatment of symptomatic, acute, closed (nonpenetrating), traumatic, cranial, or intracranial injuries confirmed by computed tomography or magnetic resonance imaging; (2) patients were excluded if initial neuroimaging revealed clear evidence of preexisting brain malformation, disease, infection, or hypoxiaischemia; or if head injuries resulted from collisions involving motor vehicles; (3) PICU providers and child abuse consultants involved directly in the patient's care worked with research coordinators to capture and verify the accuracy of all required data (including race and ethnicity); and (4) strict methods were deployed to avoid convenience sampling; to ensure complete, uniform, prospective data capture; and to eliminate missing data.

The 18 participating sites were PICUs located in US or Canadian urban centers. Fourteen of the 18 PICUs participated in both parent studies. Eligible patient volumes varied considerably across sites, from an average of <1–4 patients per month. Applying the a priori definitional criteria for AHT used in both parent studies (Table I; available at www.jpeds.com), the prevalence of AHT at individual sites varied from 23% to 75% of eligible patients.

For this secondary analysis, (1) a patient was considered "evaluated for abuse" if he or she underwent radiologic skeletal survey and/or retinal examination by an ophthalmologist; (2) a patient was considered "reported for abuse" if any professional from his or her medical treatment facility made (or verified) a report of suspected child maltreatment to a child protection or investigative agency; (3) all patients with race/ethnicity other than white/non-Hispanic were designated "minority race/ethnicity"; (4) AHT-related practice "disparity" was defined as a difference in the proportion of patients evaluated or reported for suspected AHT that was statistically significant ($P < .05$) by χ^2 analysis (or Fisher exact test for small samples); and (5) the PediBIRN 4-variable clinical prediction rule was used to calculate a patient-specific estimate of AHT probability for every patient.[16]

Analyses of the entire dataset included (1) χ^2 analysis and calculation of aORs to identify disparities in AHT evaluation and reporting in comparison groups of white/non-Hispanic and minority race/ethnicity patients from all 18 sites; and (2) χ^2 analysis (or Fisher exact test) to identify and characterize AHT-related evaluation and reporting disparities in subpopulations of white/non-Hispanic and minority race/ethnicity patients with a lower vs a higher risk for AHT. For these analyses of subsamples, patients were categorized as lower risk for AHT in 2 different ways: (1) if they were ultimately categorized as non-AHT in a parent study (Table I); and (2) if their patient-specific, estimated probability of AHT was ≤25%.

aORs were calculated for every practice comparison that revealed disparity. ORs were adjusted for differences in patient age (<6 months vs >6 months), sex, and head injury mechanism (isolated contact injuries vs any inertial injuries).

Analyses of site-specific data included (1) χ^2 analysis (or Fisher exact test) and calculation of aORs to identify disparities in AHT evaluation and reporting in comparison groups of white/non-Hispanic vs minority race/ethnicity patients at each individual site; and (2) similar analyses to identify and characterize AHT evaluation and reporting disparities in subpopulations of white/non-Hispanic and minority race/ethnicity patients with a lower vs a higher risk for AHT (a) from all sites with confirmed AHT-related practice disparities, and (b) from all remaining sites. Again, aORs were calculated for every comparison that revealed a P value of <.05.

To identify local confounders that might explain AHT-related practice disparities confirmed at specific sites, we applied χ^2 analysis (or Fisher exact test) with Bonferroni correction to identify any significant ($P < .05$) differences in the frequencies of various demographic, historical, clinical, laboratory, and radiologic “red flags” for AHT in comparison groups of minority race/ethnicity patients (a) from all sites with confirmed AHT-related practice disparities, and (b) from all remaining sites. These “AHT red flags” included age <6 months, caregiver specific denial of any trauma, acute respiratory compromise and/or encephalopathy, patterned bruising, subdural hemorrhage, and other variables (Table II).

Results

Aggregate analyses of the entire PediBIRN dataset (Figure 1) revealed minority race/ethnicity patients (n = 229) were more frequently evaluated (86% vs 72%; $P < .001$; aOR, 2.2; 95% CI, 1.4–3.6) and reported (81% vs 68%; $P = .001$; aOR, 1.9; 95% CI, 1.2–2.9) for suspected AHT than white/non-Hispanic patients (n = 271). Equivalent but more focused analyses (black/non-Hispanic vs white/non-Hispanic and white/Hispanic vs white/non-Hispanic) demonstrated that these disparities can be linked more specifically and independently to black race and/or to Hispanic ethnicity.

Aggregate data analyses also revealed that AHT evaluation and reporting disparities seemed to occur almost exclusively in lower risk patients (1) who were categorized as non-AHT in a parent study (74% vs 54% [$P = .001$; aOR, 2.4; 95% CI, 1.4–4.0] and 64% vs 47% [$P = .003$; aOR, 2.1; 95% CI, 1.3–3.5], respectively), or (2) with patient-specific estimates of AHT probability of ≤25% (73% vs 42% [$P < .001$; aOR, 4.1; 95% CI, 2.3–7.5] and 64% vs 40% [$P < .001$; aOR, 2.8; 95% CI, 1.6–4.9], respectively).

Site-specific analyses revealed that disparities in the evaluation and reporting of suspected AHT were actually limited to only 2 of 18 sites. Analysis of the combined data from these 2 sites (n = 152) (Figure 2) revealed minority race/ethnicity patients (n = 78) were more frequently evaluated (90% vs 59%; $P < .001$; aOR, 8.5; 95% CI, 3.2–22.1) and reported (88% vs 49%; $P < .001$; aOR, 16.4; 95% CI, 5.8–46.3) for suspected AHT than white/non-Hispanic patients (n = 74).

At these 2 sites, racial/ethnic disparities in AHT evaluation and reporting occurred primarily in lower risk patients (1) who were categorized as non-AHT in a parent study (86% vs 48% [$P < .001$; aOR, 8.2; 95% CI, 3.0–22.4] and 82% vs 34% [$P < .001$; aOR, 14.0; 95% CI, 4.9–40.0], respectively), or (2) with patient-specific estimates of AHT probability of ≤25% (85% vs 30% [$P < .001$; aOR, 17.9; 95% CI, 5.3–60.4] and 78% vs 25% [$P < .001$; aOR, 16.1; 95% CI, 5.0–51.4], respectively). At these 2 sites, racial/ethnic disparities in AHT reporting were also confirmed in higher risk patients with estimated probabilities of abuse of ≥25%. Although higher percentages of minority race/ethnicity than white/non-Hispanic patients were evaluated (83% vs 77%) and reported (77% vs 75%) for abuse at the remaining 16 sites, these differences were not statistically significant (Figure 3).

Additional analyses failed to identify any demographic, clinical, historical, laboratory, or neuroimaging findings ("AHT red flags") unique to the lower risk, minority race/ethnicity patient population at the 2 sites with confirmed AHT-related practice disparities that might explain these disparities (Table II). Where differences approached statistical significance, the AHT red flags were less common—not more common—at the 2 sites with confirmed practice disparities than at the remaining 16 sites. Mean and median estimates of AHT probability in lower risk, minority race/ethnicity patients at the 2 sites with confirmed AHT-related practice disparities mirrored equivalent estimates in lower risk, minority race/ethnicity patients at the remaining 16 sites.

Discussion

Similar to other clinical studies demonstrating disparities and inconsistencies in the evaluation and reporting of child physical abuse,[10–13] analysis of combined data from all 18 PediBIRN sites demonstrated that minority race/ethnicity patients were twice as likely to be evaluated and reported for suspected AHT as white/non-Hispanic patients. These disparities were largely limited to minority race/ethnicity patients with lower risk for AHT, who were 2–4 times more likely to be evaluated and reported for suspected AHT than their white/non-Hispanic counterparts. These results are similar to the results of the sentinel study of Jenny et al of missed AHT, in which patients with less severe head trauma were those most likely to be handled differently based on race/ethnicity.[10]

We hypothesized incorrectly that AHT-related practice disparities would be widespread across participating sites. Although differences were observed, site-specific analyses revealed that only 2 of 18 sites demonstrated significant ($P < .05$) differences in AHT evaluation and reporting. The disparities at these 2 sites were more extreme (higher aORs) and not limited to lower risk patients (Figure 2). These results support a conclusion that aggregate analysis of multi-center data can fail to reveal the true nature and magnitude of

AHT-related practice disparities linked to race and ethnicity at specific sites. It follows that site-specific analysis could define better the optimal focus for targeted interventions (eg, quality improvement initiatives) designed to minimize such disparities.

Our search for local confounders failed to reveal any other plausible explanation(s) for the observed disparities. Compared with lower risk, minority race/ethnicity patients at the other 16 sites, lower risk, minority race/ethnicity patients at the 2 sites with AHT-related practice disparities did not manifest significantly higher frequencies of “AHT red flags” (Table II). Where the observed differences approached statistical significance, the differences imply higher AHT risk among lower risk, minority race/ethnicity patients at the 16 remaining sites —not at the 2 sites with confirmed disparities. Finally, lower risk, minority race/ethnicity patients at these 2 sites presented with patient-specific estimates of AHT probability very similar to equivalent estimates at the remaining 16 sites (Table II).

Our results do not confirm physician implicit bias at the 2 of 18 sites. However, considered in their entirety, they do support a conclusion that the AHT-related practice disparities at these sites could indeed reflect the impact of their local providers’ implicit biases. Although located in very different geographical regions of the US, the 2 sites with AHT-related practice disparities did admit a higher percentage of eligible, racial/ethnic minority patients than the remaining 16 sites (51% vs 43%). Although this difference was not statistically significant, the high prevalence of minority race/ethnicity patients in their patient populations may have led physicians at these sites to conclude that thorough abuse evaluations of minority race/ethnicity patients resulted in fewer missed cases, thus, validating their implicit biases. If true, this would be a classic example of an ascertainment bias—looking for what one expects to find only in patients where they expect to find it and not in other patients.

The potential negative consequences of such implicit bias can be severe. For example, Jenny et al reported that 15 of their 54 patients (27.8%) with missed or unrecognized AHT were reinjured because of the delay in diagnosis, that 5 of 54 patients (9.3%) with missed AHT died, and that 4 of their 5 deaths might have been prevented by earlier recognition of abuse.[10] Conversely, doctors’ decisions to complete unnecessary abuse evaluations in patients with non-AHT can increase parental stress, expose children to additional risks, prolong hospital stays, and increase health care costs.[17,18]

These secondary analyses have multiple strengths. Our study assessed the influence of race/ethnicity on AHT evaluation and reporting practices: (1) simultaneously across multiple sites,(2) through analysis of uniform data captured prospectively,(3) applying uniform, a priori, definitional criteria for AHT,(4) using an evidence-based prediction tool to calculate patient-specific estimates of AHT probability, and (5) using those estimates to confirm the association of AHT-related practice disparities with lower AHT risk.

These secondary analyses also have limitations. Because our parent studies were strictly observational, we captured no specific information regarding AHT screening, evaluation, and reporting guidelines or procedures at participating PediBIRN sites that might explain the observed disparities at 2 participating sites, or the lack of disparities at the remaining 16 sites. In the absence of a gold standard for the diagnosis of AHT, the AHT definitional criteria (Table I) and patient-specific estimates of AHT probability used in these analyses may be inaccurate. Small patient volumes may have obscured statistical confirmation of AHT-related practice disparities at additional sites. Very likely, some reports of suspected abuse included in these analyses were initiated by health care professionals at referring emergency departments or hospitals. Such outside reports of suspected abuse could have influenced PICU providers' subsequent decisions to complete an abuse evaluation. Finally, by definition, implicit biases are unknown to the holder of such beliefs, making it impossible to assess whether or not race or ethnicity is impacting the decision making of an individual, even if they are questioned directly. Therefore, it is possible only to draw conclusions regarding implicit bias based on assumptions. In these analyses, we have assumed that our failure to identify local confounders ("AHT red flags") supports an impression of implicit bias. This assumption could be flawed.

Looking forward, practice disparities and implicit bias are best countered by consistent application of evidence-based decision rules and practice guidelines. Research is needed to determine whether or not consistent application of a validated, evidence-based, AHT screening tool (eg, the PediBIRN clinical prediction rule) could lessen AHT-related practice disparities and the negative impact of providers' implicit biases. ■

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Appendix

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Glossary

AHT	Abusive head trauma
PediBIRN	Pediatric Brain Injury Research Network
PICU	Pediatric intensive care unit

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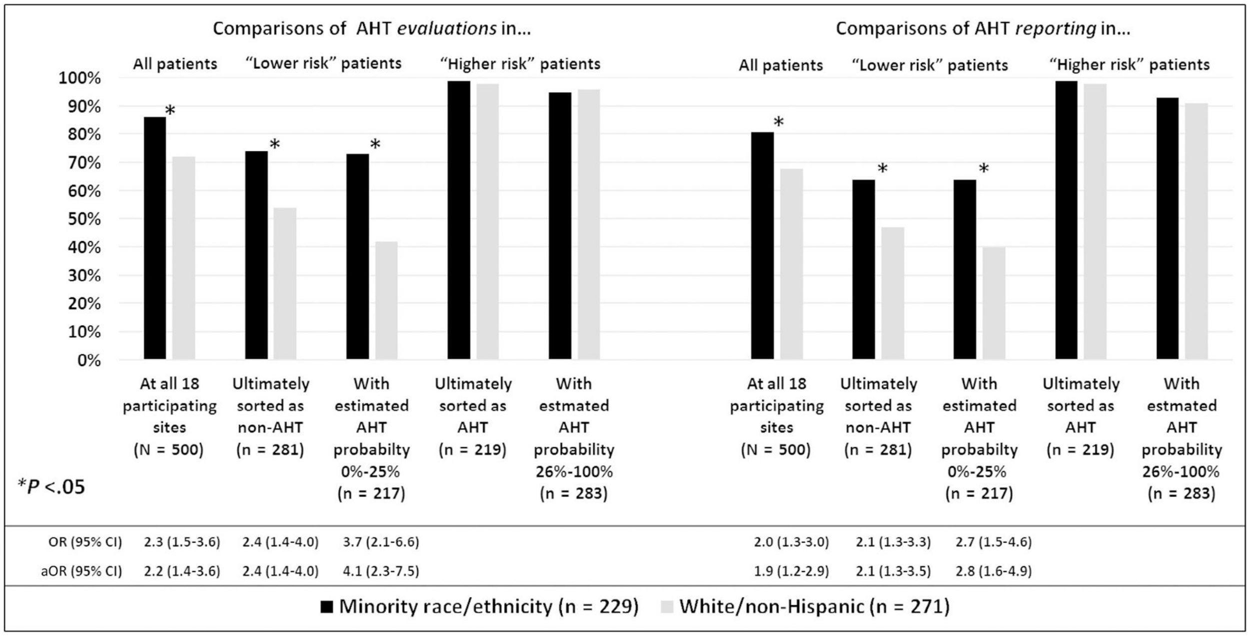

Figure 1.

Comparisons of AHT evaluation and reporting practices in white/non-Hispanic vs minority race/ethnicity patients across all 18 participating sites.

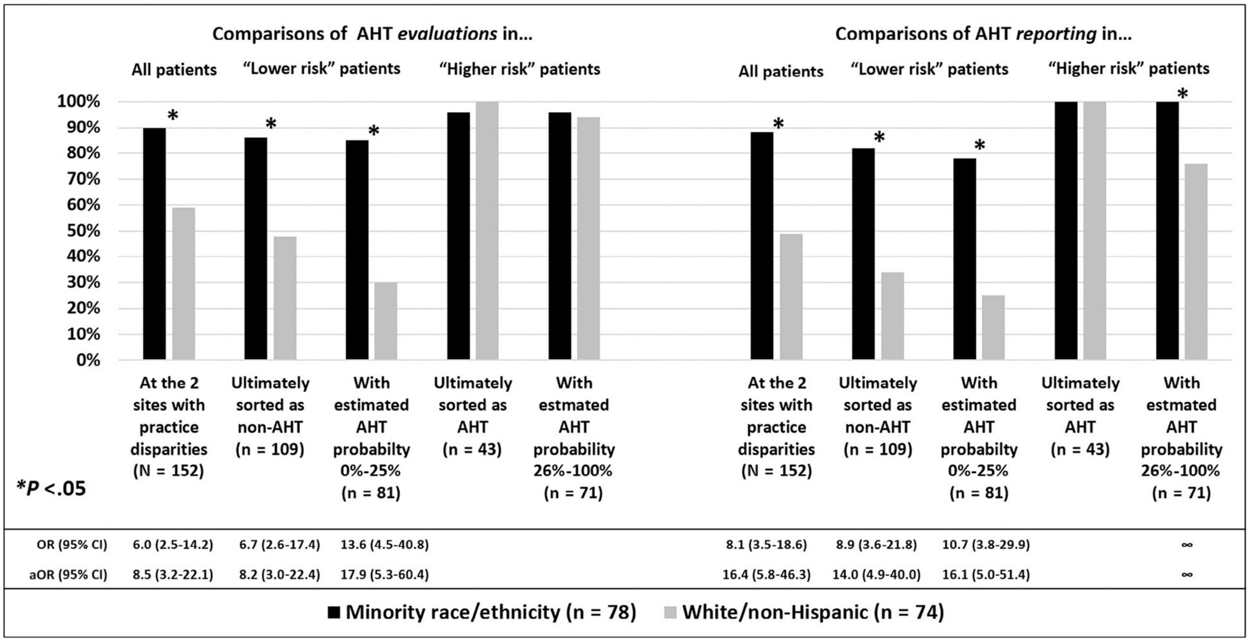

Figure 2.

Comparisons of AHT evaluation and reporting practices in white/non-Hispanic vs minority race/ethnicity patients at the 2 sites with confirmed AHT-related practice disparities.

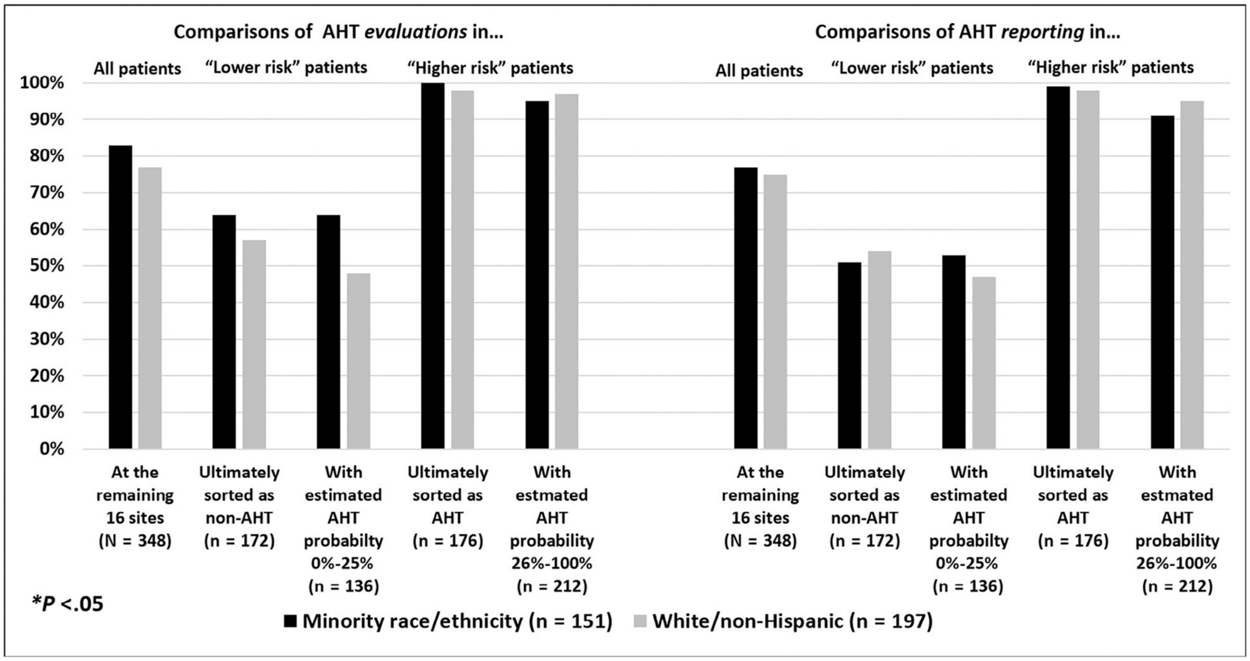

Figure 3.

Comparisons of AHT evaluation and reporting practices in white/non-Hispanic vs minority race/ethnicity patients at the remaining 16 sites.

Table I.

A priori definitional criteria for pediatric AHT

A patient was categorized as abused if…
The primary caregiver admitted abusive acts.
Abusive acts by the primary caregiver were witnessed by an unbiased, independent observer.
The primary caregiver specifically denied that the pre-ambulatory child in his or her care had experienced any head trauma.
The primary caregiver provided an account of the child's head injury event that was clearly historically inconsistent with repetition over time.
The primary caregiver provided an account of the child's head injury event that was clearly developmentally inconsistent with the child's known (or expected) gross motor skills.
Further workup confirmed the presence of ≥2 categories of extracranial injuries considered moderately or highly suspicious for abuse.*

*Including classic metaphyseal lesion fracture(s) or epiphyseal separation(s); rib fracture(s); fracture(s) of the scapula or sternum; fracture(s) of digits; vertebral body fracture(s), dislocation(s) or fracture(s) of spinous process(es); skin bruising, abrasion(s) or laceration(s) in ≥2 distinct locations other than knees, shins or elbows; patterned skin bruising or dry contact burn(s); scalding burn(s) with uniform depth, clear lines of demarcation and paucity of splash marks; confirmed intra-abdominal injuries; retinoschisis confirmed by an ophthalmologist; retinal hemorrhages described by an ophthalmologist as dense, extensive, covering a large surface area and/or extending to the ora serrata.

Table II.

Comparisons of AHT “red flags” in lower risk, minority race/ethnicity patients at the 2 sites with AHT-related practice disparities vs at the remaining 16 participating sites

Comparisons of “Lower Risk” Minority Race/Ethnicity Patients	Ultimately sorted as non-AHT (n = 121)				With estimated AHT probabilities 0–25% (n = 96)			
AHT “Red Flags”	At the 2 sites with practice disparities (n = 51)	At the remaining 16 participating sites (n = 70)	*P* values*	Adjusted *P* values†	At the 2 sites with practice disparities (n = 41)	At the remaining 16 participating sites (n = 55)	*P* values*	Adjusted *P* values†
Age, development, history								
Age <6 mo	21 (41)	25 (36)	.541	1.000	18 (44)	22 (40)	.701	1.000
Not yet cruising/walking	37 (73)	44 (63)	.263	1.000	31 (76)	38 (69)	.482	1.000
Caregiver specific denial of any trauma	3 (6)	0 (0)	.072	1.000	4 (10)	3 (5)	.456	1.000
Acute clinical presentation								
Encephalopathy	14 (27)	37 (53)	.005	.090	5 (12)	22 (40)	.003	.054
Seizure(s)	8 (16)	13 (19)	.679	1.000	1 (2)	8 (15)	.073	1.000
Respiratory compromise	11 (22)	21 (30)	.299	1.000	3 (7)	6 (11)	.728	1.000
Physical examination findings								
Bruising of the torso, ear(s), or neck	1 (2)	2 (3)	1.000	1.000	0 (0)	0 (0)	1.000	1.000
Patterned bruising or dry contact burns	0 (0)	0 (0)	1.000	1.000	1 (2)	0 (0)	.427	1.000
Skin injuries in multiple, distinct, locations	2 (4)	2 (3)	1.000	1.000	2 (5)	2 (4)	1.000	1.000
“Other injuries suspicious for abuse”	5 (10)	5 (7)	.741	1.000	3 (7)	8 (15)	.343	1.000
Screen for blunt abdominal trauma								
AST or ALT of >80 IU/L	6 (12)	9 (13)	.857	1.000	5 (12)	4 (7)	.490	1.000
Neuroimaging findings								
Complex skull fracture(s)	20 (39)	23 (33)	.471	1.000	18 (44)	22 (40)	.701	1.000
Any subdural hemorrhage or fluid collection	24 (47)	31 (44)	.762	1.000	14 (34)	16 (29)	.597	1.000
Any brain contusion, laceration, or hemorrhage	11 (22)	10 (14)	.296	1.000	7 (17)	10 (18)	.888	1.000
Any brain hypoxia, ischemia, or swelling	6 (12)	13 (19)	.310	1.000	1 (2)	8 (15)	.073	1.000

Comparisons of "Lower Risk" Minority Race/Ethnicity Patients

AHT "Red Flags"	Ultimately sorted as non-AHT (n = 121)				With estimated AHT probabilities 0–25% (n = 96)			
	At the 2 sites with practice disparities (n = 51)	At the remaining 16 participating sites (n = 70)	*P* values*	Adjusted *P* values†	At the 2 sites with practice disparities (n = 41)	At the remaining 16 participating sites (n = 55)	*P* values*	Adjusted *P* values†
Head Injury Mechanism(s)								
Any inertial injuries‡	14 (27)	37 (53)	.005	.090	5 (12)	22 (40)	.003	.054
Results of completed abuse evaluations								
Extensive retinal hemorrhages or retinoschisis	4 (8)	5 (7)	1.000	1.000	0 (0)	0 (0)	1.000	1.000
Skeletal fracture(s) moderately/highly specific for abuse	1 (2)	3 (4)	.638	1.000	1 (2)	3 (5)	.633	1.000
Estimated probability of abuse at admission								
Median	0.11	0.07			0.07	0.07		
Mean	0.22	0.23			0.10	0.09		
SD	0.23	0.24			0.05	0.03		
Range	0.06–0.77	0.06–0.83			0.06–0.23	0.06–0.23		

ALT, Alanine aminotransferase; *AST*, aspartate aminotransferase.

Values are n (%) unless otherwise noted.

* By χ^2 or Fisher exact testing (for small populations).

† By χ^2 or Fisher exact testing (for small populations), applying Bonferroni adjustment to control the family-wise error rate.

‡ Including acute encephalopathy prior to admission, or brain parenchymal contusion(s), laceration(s), or hemorrhage(s) interpreted as diffuse axonal injury.