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ORIGINAL RESEARCH ARTICLE

Occult Abdominal Trauma Screening in the Evaluation of Suspected Child Physical Abuse

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ABSTRACT

BACKGROUND AND OBJECTIVES: Occult abdominal trauma (OAT) screening with transaminases, followed by abdominal computed tomography (CT) for transaminase values greater than 80 IU/L, has been recommended in cases of suspected physical abuse. This study aimed to evaluate case characteristics associated with OAT evaluation and determine OAT prevalence in these children.

METHODS: Injured children aged younger than 60 months undergoing Child Abuse Pediatrics (CAP) consultation for suspected physical abuse from February 2021 to May 2023 were identified in CAPNET, a multicenter research network. Children with symptoms or signs of intra-abdominal injury were excluded. We identified case characteristics associated with transaminase screening and abdominal CT imaging using logistic regression and determined OAT prevalence.

RESULTS: Of 6161 eligible children, 3982 (64.6%) underwent transaminase screening; 687/3982 (17.3%) had transaminases greater than 80 IU/L with 298/687 (43.4%) undergoing abdominal CT imaging. Variability in screening and imaging practices was identified between CAPNET sites. In a fully adjusted model, transaminase screening was associated with ages younger than 6 months, greater clinical severity, and site. CT imaging was associated with site, inpatient status, and higher transaminase range. We identified 16 OAT cases in children with transaminases greater than 80 IU/L, representing 2.3% of CAP-evaluated children with positive transaminase screening and 0.3% of all eligible children.

CONCLUSIONS: Providers often perform transaminase screening but not abdominal CT imaging despite transaminases greater than 80 IU/L. The low prevalence of OAT suggests that routine transaminase screening in suspected child physical abuse evaluations may not be necessary when all signs and symptoms of abdominal injury are absent.

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Drs Tagrid Ruiz-Maldonado and Kristine Campbell conceptualized and designed the study, collected data, carried out the initial analyses, drafted the initial manuscript, and critically reviewed and revised the manuscript. Dr Joanne Wood collected data, helped in coordinating and supervising data collection, provided statistical input, and critically reviewed and revised the manuscript for important intellectual content. Dr Caitlin Crumm participated in the analysis and interpretation of data and critically reviewed and revised the manuscript. (Continued)

WHAT'S KNOWN ON THIS SUBJECT: Transaminase screening and computed tomography imaging of the abdomen have been recommended for identification of occult abdominal trauma (OAT) in suspected child physical abuse. Despite this, provider practice and patient outcomes for OAT screening in physical abuse evaluations are unknown.

WHAT THIS STUDY ADDS: This study describes clinical characteristics of patients where provider concern for OAT is heightened and reveals that truly occult abdominal injury is uncommon. Routine screening for OAT may not be warranted.

Introduction

Intra-abdominal injuries related to child physical abuse may be clinically occult, presenting without gastrointestinal signs or symptoms. Hepatic transaminases, aspartate transaminase (AST) and alanine transaminase (ALT), have been recommended as clinical biomarkers for abdominal injury.[1,2] Two large, multicenter studies assessed transaminase screening in children referred to a child abuse pediatrics (CAP) specialist for physical abuse evaluation and identified an 80-IU/L cutoff value for either transaminase (ie, AST or ALT) as an indicator that abdominal computed tomography (CT) imaging may be warranted.[3,4] Although these studies did not specifically address occult abdominal trauma (OAT), the derived recommendations have been incorporated into CAP clinical guidelines and extrapolated to OAT evaluation.[5] These child-abuse specific guidelines differ from trauma surgery guidelines suggesting thresholds of AST greater than 200 IU/L or ALT greater than 125 IU/L for abdominal CT imaging, and the yield and applicability of the proposed 80-IU/L cutoff in a pediatric population without signs or symptoms of abdominal injury remains unclear.[6–8] Concerns exist that overestimating OAT screening yields may result in increased patient cost and avoidable health risks associated with abdominal CT imaging.[9–12] We aimed to (1) examine provider practice related to OAT screening in children aged younger than 60 months evaluated for physical abuse and (2) determine the prevalence of OAT in these cases. We hypothesized that OAT evaluation practices vary significantly across CAPNET sites and that despite this variability, markers of increased clinical concern such as clinical severity, hospital admission, and younger patient age would be associated with increased transaminase screening. Additionally, we hypothesized that high-range values (AST > 200 IU/L or ALT > 125 IU/L) would be associated with increased abdominal CT imaging.

Methods

Data Source

CAPNET collects data on children referred to CAP providers for suspected physical abuse across 10 tertiary care pediatric hospitals in the United States. Sites prospectively contribute data through shared REDCap (Research Electronic Data Capture; Vanderbilt University) forms completed by the evaluating CAP provider or trained data collectors, depending on the study site. Data are subject to previously published quality procedures.[13,14] CAPNET inclusion requires an age of less than 10 years at encounter start, clinical evaluation by a CAP provider due to recent (<1 month) concerns for physical abuse, and evaluation within a CAPNET site with documentation in the electronic medical record (EHR). CAPNET encounters are typically completed within 6 weeks from initial CAP contact. The information uploaded to CAPNET reflects the total evaluation, including treating physician initial recommendations, such as emergency department (ED) or pediatric intensive care unit (PICU) providers, as well as CAP provider recommendations. The sequence or timing of recommendations cannot be determined with CAPNET. Specific to this study, data collection included consultation setting; presenting chief complaint and physical examination findings, especially whether abdominal signs were present or gastrointestinal symptoms reported; laboratory work obtained, including hepatic transaminases; and imaging performed, including abdominal CT imaging. CAPNET data registry procedures and use of CAPNET data for research have been approved or deemed exempt by each participating center's institutional review board.

Study Design

We conducted a cross-sectional, retrospective study using CAPNET data from February 2021 to May 2023. Our study population included children who were aged younger than 60 months with a mucocutaneous, musculoskeletal, intracranial, or spinal injury identified on physical examination or radiological imaging that prompted CAP consultation for physical abuse. We excluded children with signs or symptoms that would raise concern for intra-abdominal injury, specifically abdominal bruising, distention, or tenderness, hematemesis, hematochezia, hematuria, or a history of abdominal trauma. Although vomiting may reasonably prompt evaluation for both neurological and gastrointestinal etiologies, we included patients presenting with vomiting and no other signs or symptoms suggesting abdominal injury given that vomiting is a nonspecific sign of abdominal injury and may be more often associated with head trauma in this population.[15]

We studied 4 outcomes: (1) transaminase screening, defined as documentation of hepatic transaminase values; (2) positive transaminase screening, defined as either AST or ALT greater than 80 IU/L; (3) abdominal CT imaging, defined as documentation of abdominal CT results; and (4) OAT, defined as abdominal solid organ or hollow viscus injury identified by abdominal CT in the absence of external examination findings, reported symptoms, or historical indicators suggesting abdominal injury or trauma. The CAPNET database transaminase field uses the first transaminase value, or pair of values, documented during the clinical encounter. When both ALT and AST were available, we selected the highest transaminase value (ALT or AST) as the screening value for this analysis. Determining at what point in the evaluation screening may have occurred is not possible with CAPNET data. Consistent with prior studies, we defined intra-abdominal injury as evidence of hepatic, splenic, pancreatic, adrenal, or renal laceration, contusion, or vascular injury; hollow viscus hematoma or perforation; or mesenteric hematoma or tear.[1,6] Isolated nonspecific findings such as small amounts of free peritoneal fluid or air, or bowel wall edema of unclear etiology were not defined as intra-abdominal injury.

We selected covariates based on clinically important case characteristics identified in previously published OAT research.[2,7,10] Specifically, we selected sex, age, clinical severity, transaminase range, and CAPNET site. Given race- and ethnicity-driven differential screening and evaluation practices reported in prior studies, race and ethnicity were also selected covariates.[16–18] CAPNET collects race and ethnicity based on EHR documentation. When multiple races were reported, we recategorized race as "multiracial," and race reported as "other" was either recategorized when specific information was available or categorized as "some other race," in accordance with the US Office of Management and Budget standards.[19] We categorized race and ethnicity as "not reported" when these were missing or reported as "unknown." Racial and ethnic minorities were modeled separately in bivariable comparisons and multivariable logistic regressions. Sex was defined as sex assigned at birth. For 2 cases, sex was reported as unknown and thus the cases were excluded. Age was categorized based on differences in development and risk for physical abuse across age groups[20]: ages younger than 6 months, ages 6 months to younger than 12 months, ages 12 months to younger than 18 months, ages 18 months to younger than 24 months, and ages 24 months to younger than 60 months. We categorized clinical severity given the highest level of care recorded and according to whether the patient experienced a near-fatal event due to suspected maltreatment, defined as having required mechanical ventilation, treatment for an arrhythmia, or reversal of an intoxication.[21] Three levels of clinical severity were defined: (1) outpatient or ED admission without near-fatality, (2) inpatient admission without near-fatality, or (3) intensive care unit (ICU) admission with or without near-fatality, or a near-fatality without ICU admission. Positive transaminase screens (>80 IU/L) were categorized as midrange for AST less than or equal to 200 IU/L and ALT less than or equal to 125 IU/L, or as high-range for AST greater than 200 IU/L or ALT greater than 125 IU/L.[10]

We determined the prevalence of each outcome, noting variation in transaminase screening and abdominal CT imaging practices across CAPNET sites. To account for incomplete evaluations, we used a sensitivity analysis to determine the expected prevalence, assuming complete compliance with current OAT screening recommendations. Associations between each outcome and patient characteristics were examined by bivariable comparisons using χ^2 testing. We subsequently compared transaminase screening and abdominal CT imaging across CAPNET sites with multivariable logistic regression adjusted for CAPNET site. All analyses were performed in Stata version 17.0 BE (StataCorp LLC), and the threshold for statistical significance was a *P* value of less than or equal to .05. Model results are reported as adjusted predicted probabilities and adjusted marginal effects with 95% CIs, providing an estimated probability of each outcome while adjusting for all covariates in the model and thus a more practical understanding of the effect of a variable than the adjusted odds ratio.[22]

Results

Over the study time frame, 6161 children met our eligibility criteria with a median (IQR) age of 7.4 months (2.9–18.1 months) and a male (3623/6161, 58.8%), non-Hispanic (4317/6161, 71.1%), white (3539/6161, 57.4%) predominance (Table 1).

Most eligible children (3982/6161, 64.6%) underwent transaminase screening during the CAPNET encounter (Figure 1). In bivariable comparison, we found significant differences in transaminase screening based on race, ethnicity, age, and clinical severity (all $P < .001$; Table 2). We identified significant

TABLE 1. Study Population Characteristics (N = 6161)

Characteristics	
Median age, months (IQR)	7.4 (2.9–18.1)
Age group, n (%)	
<6 mo	2277 (37.0)
6 to <12 mo	1353 (22.0)
12 to <18 mo	572 (9.3)
18 to <24 mo	484 (7.9)
24 to 60 mo	1475 (23.9)
Sex, n (%)	
Female	2538 (41.2)
Race, n (%)	
American Indian or Alaska Native	41 (0.7)
Asian	112 (1.8)
Black or African American	1177 (19.1)
Native Hawaiian or Other Pacific Islander	21 (0.3)
White	3539 (57.4)
Multiracial	346 (5.6)
Some other race	45 (0.7)
Not reported	880 (14.3)
Ethnicity, n (%)	
Non-Hispanic or Latino	4317 (70.1)
Hispanic or Latino	1260 (20.5)
Unknown/not reported	584 (9.5)
Clinical severity,[a] n (%)	
Severity level 1	3286 (53.3)
Severity level 2	2037 (33.1)
Severity level 3	838 (13.6)

Abbreviations: N, total study population; n, sample size.

[a] Clinical severity was assigned levels 1 through 3, where 1 = outpatient or emergency department admission without near-fatality, 2 = inpatient admission without near-fatality, and 3 = admission with or without near-fatality or near-fatality without intensive care unit admission.

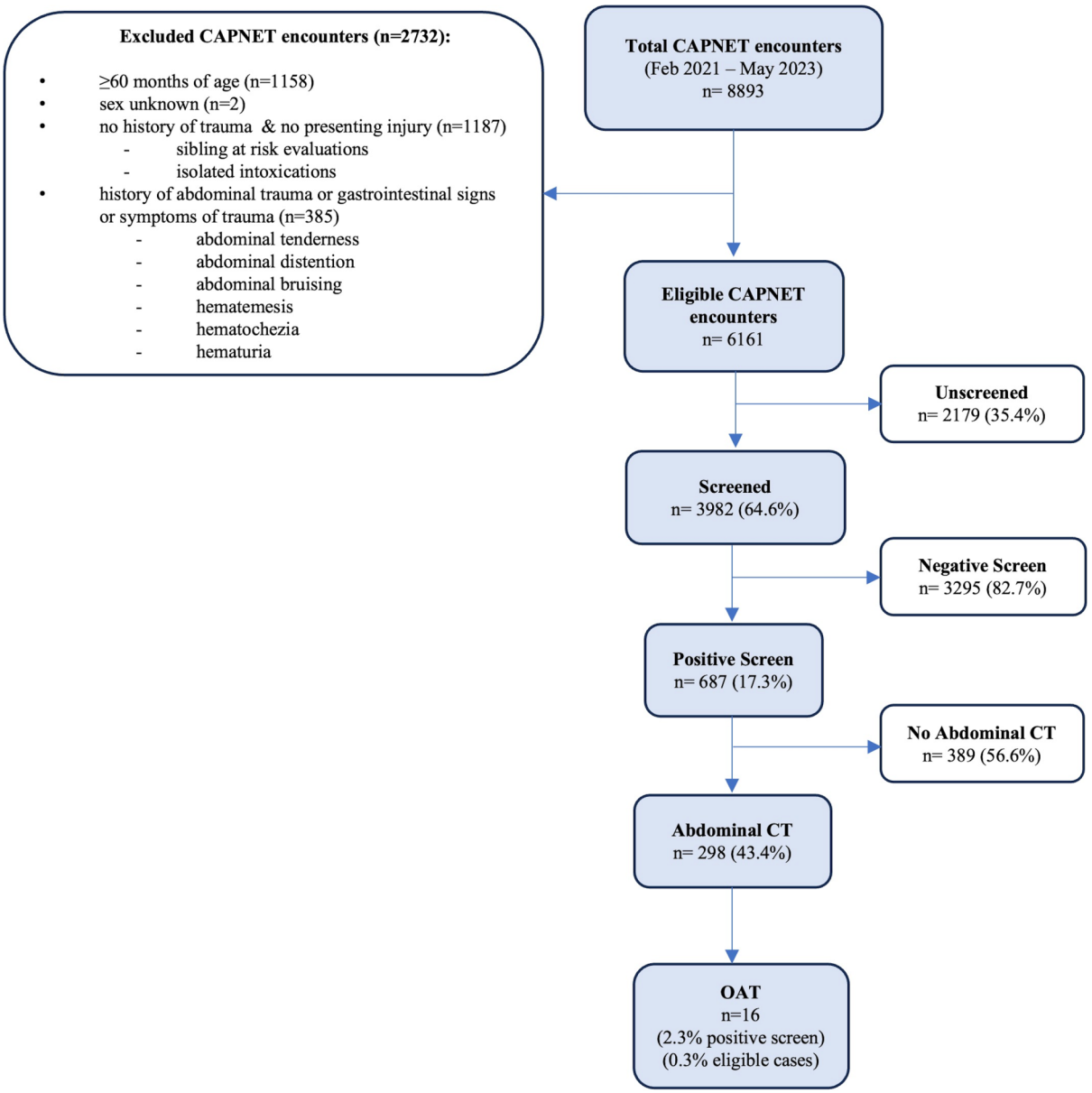

FIGURE 1. Study population flow diagram. Screened and Unscreened refers to having obtained transaminases or not; Positive Screen refers to AST or ALT greater than 80 IU/L; Negative Screen refers to AST or ALT less than or equal to 80 IU/L.
Abbreviations: CT, computed tomography; n, sample size; OAT, occult abdominal trauma.

variability in transaminase screening across CAPNET sites ($P < .001$; Figure 2). In multivariable analyses adjusted for this variability, patients aged younger than 6 months and patients with greater clinical severity were more likely to have transaminase screening (all $P < .001$; Table 3). Adjusted multivariable analysis no longer identified a significant association between transaminase screening and ethnic or racial minority, although it did reveal a negative association between transaminase screening and unreported ethnicity ($P = .002$).

Of 3982 children screened with transaminases, 687 (17.3%) had a positive screen with at least 1 transaminase result greater than 80 IU/L. Of these, 298 (43.4%) were imaged by abdominal CT (Figure 1). We identified a significant difference in positive transaminase values between imaged and unimaged patients with imaged cases having higher transaminase values ($P < .001$; Table 2). In bivariable comparison, we found significant differences in abdominal CT imaging by clinical severity ($P = .05$) and transaminase range ($P < .001$). We again identified significant variability in abdominal CT imaging across CAPNET sites ($P < .001$; Figure 3). In fully adjusted multivariable analysis, patients admitted to the hospital without near-fatality ($P = .01$) and those with high-range transaminase values ($P < .001$) were

TABLE 2. Patient Characteristics Among Screened and CT-Imaged Cases (N = 6161)

			Among Screened Patients With Transaminases > 80 IU/L (n = 687)	
Patient Characteristics	**Screened Cases (n = 3982)**	**Unscreened Cases (n = 2179)**	**CT-Imaged Cases (n = 298)**	**Unimaged Cases (n = 389)**
Median, months (IQR)	5.9 (2.5–12.6)	15.4 (6.8–32.7)	4.9 (2.4–13.7)	4.5 (2.0–9.7)
Age group,[a] n (%)				
<6 mo	1841 (46.2)	436 (20.0)	158 (53.0)	221 (56.8)
6 to <12 mo	955 (24.0)	398 (18.3)	56 (18.8)	85 (21.9)
12 to <18 mo	350 (8.8)	222 (10.2)	25 (8.4)	31 (8.0)
18 to <24 mo	243 (6.1)	241 (11.1)	19 (6.4)	15 (3.9)
24 to 60 mo	593 (14.9)	882 (40.5)	40 (13.4)	37 (9.5)
Sex, n (%)				
Female	1608 (40.4)	930 (42.7)	122 (40.9)	154 (39.6)
Race,[a] n (%)				
White	2247 (56.4)	1292 (59.3)	143 (48.0)	201 (51.7)
Racial Minority	1197 (30.1)	545 (25.0)	102 (34.2)	141 (36.2)
Not Reported	538 (13.5)	342 (15.7)	53 (17.8)	47 (12.1)
Ethnicity,[a] n (%)				
Non-Hispanic or Latino	2853 (71.6)	1464 (67.2)	199 (66.8)	240 (70.8)
Hispanic or Latino	793 (19.9)	467 (21.4)	61 (20.5)	71 (20.9)
Not Reported	336 (8.4)	248 (11.4)	38 (12.8)	28 (8.3)
Clinical severity[a,b], n (%)				
Severity level 1	1458 (36.6)	1828 (83.9)	47 (15.8)	87 (22.4)
Severity level 2	1755 (44.1)	282 (12.9)	146 (49.0)	160 (41.1)
Severity level 3	769 (19.3)	69 (3.2)	105 (35.2)	142 (36.5)
ALT or AST				
Median, IU/L (IQR)	49 (39–68)	N/A	139 (103–266)	102 (88–140)
Transaminase range[b,c], n (%)				
Midrange	486 (12.2)	N/A	171 (57.4)	315 (81.0)
High-range	201 (5.0)	N/A	127 (42.6)	74 (19.0)

Abbreviations: CT, computed tomography; n, sample size; N/A, not applicable.
[a] *P* values ≤ .05 in bivariable comparisons for transaminase screening.
[b] *P* values ≤ .05 in bivariable comparisons for abdominal CT imaging.
[c] Positive transaminase values (AST or ALT >80 IU/L) were categorized midrange if AST ≤ 200 IU/L and ALT ≤ 125 IU/L and high-range if AST > 200 IU/L or ALT > 125 IU/L.

more likely to receive abdominal CT imaging (Table 3). Although bivariable comparisons did not reveal significant differences in abdominal CT imaging by race, adjusted multivariable regression identified a positive association between abdominal CT imaging and patients with an unreported race ($P = .03$).

We identified 16 cases of OAT among 687 children with positive transaminase screening (2.3%) (Table 4), yielding a 0.3% prevalence (95% CI, 0.2% 0.4%) of OAT among patients evaluated for suspected physical abuse (16/6161). As not all children in our population were screened or imaged according to current recommendations, this is a conservative estimate of OAT prevalence and provides a lower bound of a sensitivity analysis. To estimate an upper bound of OAT prevalence, we assumed a rate of elevated transaminases in the unscreened population equivalent to that observed in the screened population and a rate of positive imaging in the total population of children with elevated transaminases to be the same as that in the observed population (Figure 4). Under this assumption, approximately 1065 children would have a positive transaminase screen and approximately 58 cases of OAT would be identified, establishing the upper bound of OAT prevalence at 5.5% (95% CI, 4.2% 7.0%) in children with positive transaminase screening and 0.9%

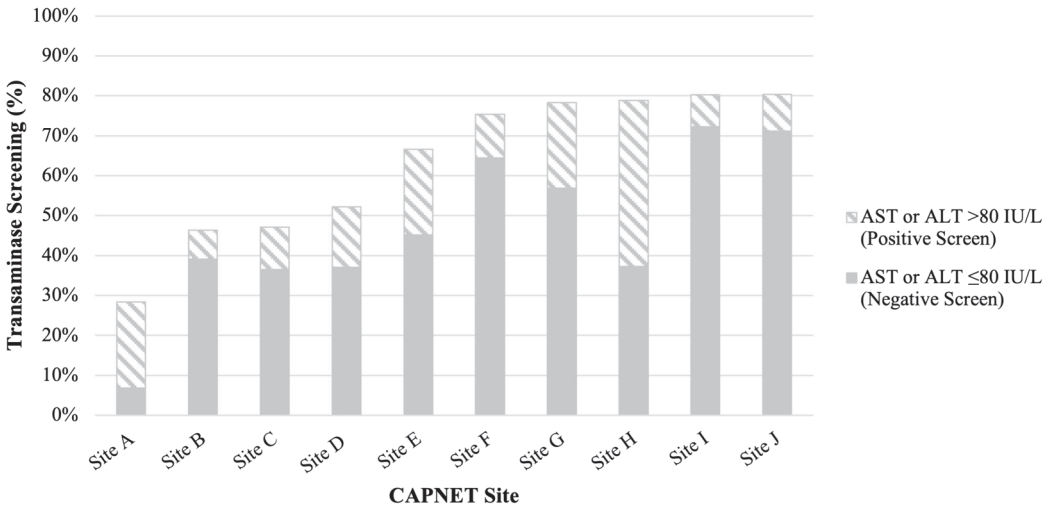

FIGURE 2. Transaminase screening variability across CAPNET sites. Significant variability in transaminase screening practices across CAPNET sites ($P < .001$).

TABLE 3. Adjusted Predicted Probability of Transaminase Screening and Abdominal CT Imaging After Logistic Regression Analysis

Patient Characteristics	Transaminase Screening		Abdominal CT Imaging (When Transaminase >80 IU/L)	
	Predicted Probability (%)	95% CI	Predicted Probability (%)	95% CI
Age group				
<6 mo[a]	74.6	72.9–76.4	43.5	39.2–47.8
6 to <12 mo	69.0	66.9–71.1	38.4	31.4–45.3
12 to <18 mo	64.9	61.7–68.1	44.1	32.9–55.3
18 to <24 mo	57.1	53.5–60.7	56.1	41.4–70.7
24 to 60 mo	51.1	48.9–53.3	46.5	36.7–56.3
Race				
White	64.4	63.1–65.7	39.3	34.9–43.8
Racial minority	64.5	62.6–66.4	46.1	40.1–52.0
Not reported[b]	65.8	62.8–68.7	51.7	42.2–61.2
Ethnicity				
Non-Hispanic or Latino	64.9	63.7–66.1	43.5	39.4–47.6
Hispanic or Latino	66.0	63.7–68.3	44.6	37.4–51.8
Not reported[a]	59.5	55.9–63.2	40.2	29.5–50.9
Clinical severity				
Severity level 1	49.8	48.2–51.5	37.8	30.3–45.3
Severity level 2[b]	82.0	80.4–83.7	49.5	44.7–54.3
Severity level 3	88.7	86.4–91.0	39.1	33.8–44.4
Transaminase range				
Midrange	N/A	N/A	37.2	33.3–41.2
High-range[b]	N/A	N/A	57.4	51.1–63.6

Abbreviation: CT, computed tomography; N/A, not applicable.

Probabilities reflect multivariable adjustment for all listed variables as well as for site variability (not reported here).

[a] P values ≤ .05 for transaminase screening.

[b] P values ≤ .05 for abdominal CT imaging.

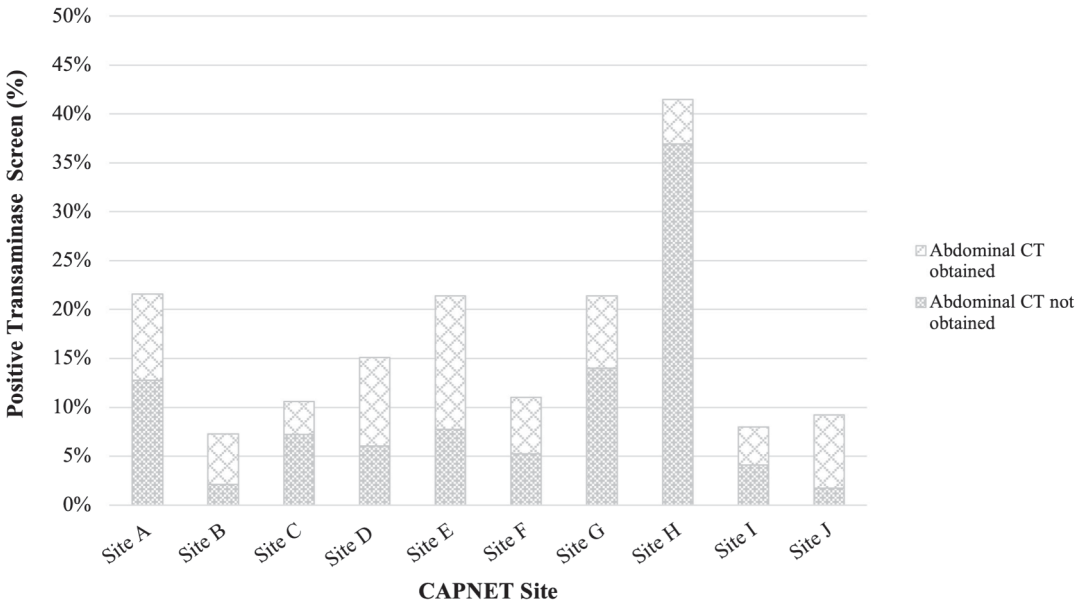

FIGURE 3. Abdominal CT imaging variability across CAPNET sites. Significant variability in obtaining abdominal CT for patients with positive transaminase screen (>80 IU/L) across CAPNET sites ($P < .001$).
Abbreviation: CT, computed tomography.

(95% CI, 0.7% 1.2%) in our study's eligible population. Thus, we estimate that 19 to 43 additional abdominal CT scans would be needed to identify each additional case of OAT.

Discussion

This study identified wide variation in OAT screening across CAPNET centers, indicating a lack of consensus regarding OAT evaluation. The average transaminase screening rate in our eligible population reveals an increase when compared with prior studies, although we notably excluded children with signs of abdominal injury and prior studies did not.[2,6] The significant associations we identified support a previously published provider preference for screening cases of serious injury.[4] Our results reveal that, despite increased transaminase screening, OAT remains an uncommon diagnosis in children undergoing evaluation of suspected physical abuse.

Although transaminase screening was frequently performed, abdominal CT imaging in cases of positive screens was notably lower. Under these real-world CAP screening practices, OAT was diagnosed in 0.3% of all eligible children and in 2.3% of children with positive transaminase screens. As imaging does not occur at random, children who were not imaged were likely determined to be at lower risk for OAT by clinicians, suggesting the upper bound of 5.4% identified by the sensitivity analysis is likely an overestimate. It is challenging to compare these results to prior publications given the aforementioned differences in study designs. However, when estimating OAT yields as defined in our study, published results are comparable to the low estimated yields we have identified.[2,3]

The low rate of imaging among children with positive transaminase screens and the significant association between imaging and higher transaminase values, as well as inpatient status suggest that not all providers are following the suggested cutoff value of 80 IU/L to guide abdominal CT imaging recommendations in children without signs or symptoms of abdominal injury. Instead, providers are likely considering the degree of transaminase elevation along with injury severity, perceived likelihood of abuse, varying institutional protocols, personal variability, and other unmeasured confounders not captured in CAPNET.

We identified an association between higher ranges of transaminase values and abdominal CT imaging, which may reflect CAP awareness of higher transaminase cutoffs in the trauma surgery literature. Trauma-proposed cutoffs are designed to detect cases of abdominal injury with potential for surgical management or care escalation.[23–25] In our cohort, none of the identified occult abdominal injuries required surgical repair and long-term disability or death were unlikely direct results of OAT and instead were due to concurrent injuries. Proponents of OAT screening in child physical abuse evaluations have argued that because of potential forensic implications, rather than surgical relevance, a lower threshold for imaging should be adopted. However, given the low rate of abdominal CT imaging despite positive transaminase screens as well as the association between higher transaminase ranges and abdominal CT imaging, our findings suggest discomfort with the suggested 80-IU/L threshold. We argue that this concern is appropriate given the relatively low yield of these imaging practices.

TABLE 4. Clinical Findings of Cases Screened and Imaged Revealing OAT When AST or ALT Greater Than 80 IU/L

Case #	Age, mo	AST, ALT (IU/L)	Clinical Severity Level[a]	Surgical Intervention[b]	OAT Identified[c]	Concurrent Injury Types[d]	Clinical Outcomes[e]
1	0.2	83, 21	2	(-)	Grade 1 hepatic injury	MSK	ND
2	0.5	1233, 504	2	(-)	Grade 3 hepatic injury Grade 1 pancreatic injury	MCI, IC	ND
3	2	88, 103	3	(-)	Grade 2 hepatic injury Grade 3 splenic injury	MCI, MSK, IC	LTD
4	2.3	1195, 805	3	(-)	Grade 2 hepatic injury	MCI, MSK, IC	NR
5	3.8	242, 667	2	(-)	Grade 2 hepatic injury	MCI, MSK	STD
6	7.8	189, 201	3	(-)	Grade 3 hepatic injury	MCI, MSK, IC	STD
7	8.8	603, 891	2	(-)	Grade 1 hepatic injury	MSK	STD
8	13	113, 1099	2	(-)	Grade 2 hepatic injury Grade 2 splenic injury Grade 5 adrenal injury	MCI, MSK	STD
9	14	373, 861	2	(-)	Grade 2 hepatic injury	MCI, MSK	STD
10	15	96, 191	2	(-)	Grade 1 hepatic injury	MCI, MSK	STD
11	20	546, 441	2	(-)	Grade 3 hepatic injury	MSK	STD
12	32	472, 1169	2	(-)	Grade 1 hepatic injury Renal injury, unspecified Grade 1 adrenal injury	MCI	STD
13	38	149, 266	2	(-)	Grade 2 hepatic injury	MCI	ND
14	38	341, 1598	2	(-)	Grade 3 hepatic injury	MCI, MSK	NR
15	44	147, 379	2	(-)	Grade 4 hepatic injury	MCI	ND
16	50	189, 177	1	(-)	Grade 3 hepatic injury	MCI, MSK, IC	Death

Abbreviations: IC, intracranial; LTD, long-term disability; MCI, mucocutaneous injury; MSK, musculoskeletal; ND, no disability; NR, not reported; OAT, occult abdominal trauma; STD, short-term disability.

[a] Clinical severity was assigned levels 1 through 3, where 1 = outpatient or emergency department admission without near-fatality, 2 = inpatient admission without near-fatality, and 3 = intensive care unit admission with or without near-fatality or near-fatality without intensive care unit admission.

[b] CAPNET defines surgical intervention as an abdominal injury that required surgical repair.

[c] OAT-specific injuries were reported in accordance with grading systems endorsed by The American Association for the Surgery of Trauma and were clinically managed according to institutional practices; specific injury (ie, laceration vs contusion) not captured by CAPNET.

[d] Includes MSK (fractures), MCI (bruising, burns, oral injury, subconjunctival hemorrhage), and IC (hemorrhage, parenchymal contusion or laceration). No spinal injuries were identified.

[e] Outcomes include ND or STD defined as a new disability lasting less than 6 months; LTD defined as disability or consciousness impairment lasting 6 months or more; death; and NR.

In attempting to balance the forensic or clinical benefit of identifying an injury and the risks related to screening and imaging, providers may find it helpful to consider the reported yields and radiation risks of other radiologic studies commonly used to screen for occult injuries in physical abuse evaluations. Skeletal survey yields for occult fractures in children aged younger than 24 months evaluated for physical abuse have been reported at approximately 11%.[26] Follow-up skeletal surveys performed 10 to 14 days after initial evaluation have reportedly revealed a previously unrecognized skeletal injury in 15.6% of cases.[27] Head CTs performed in children aged younger than 6 months evaluated for physical abuse have reportedly revealed occult intracranial hemorrhage in 1 in 10 imaged cases.[28] In comparison, our findings suggest that with an estimated 0.3% prevalence in all children evaluated for physical abuse and a prevalence ranging from 2.5% to an estimated 5.4% upper bound in children with a positive transaminase screen, OAT prevalence is notably lower than that of other occult injuries. Furthermore, a skeletal survey delivers a radiation dose equivalent to approximately 1 month of natural background radiation, and a noncontrast head CT delivers the equivalent of approximately 1 year.[29,30] Even with ALARA (As Low As Reasonably Achievable) considerations, the abdominal CT remains a relative high-radiation modality delivering doses equivalent to approximately 3 years of natural background radiation in a single scan.[31]

This study had some notable strengths. CAPNET reflects the largest and most current CAP-collected data available allowing for an accurate depiction of current practice trends across a wide range of clinical settings. Additionally, CAPNET allows for identification and exclusion of children with signs or symptoms of intra-abdominal injury, which prior multicenter studies did not pursue. There are also several important limitations. First, inherent to the retrospective study design, many evaluations were incomplete where a child may have been screened but not

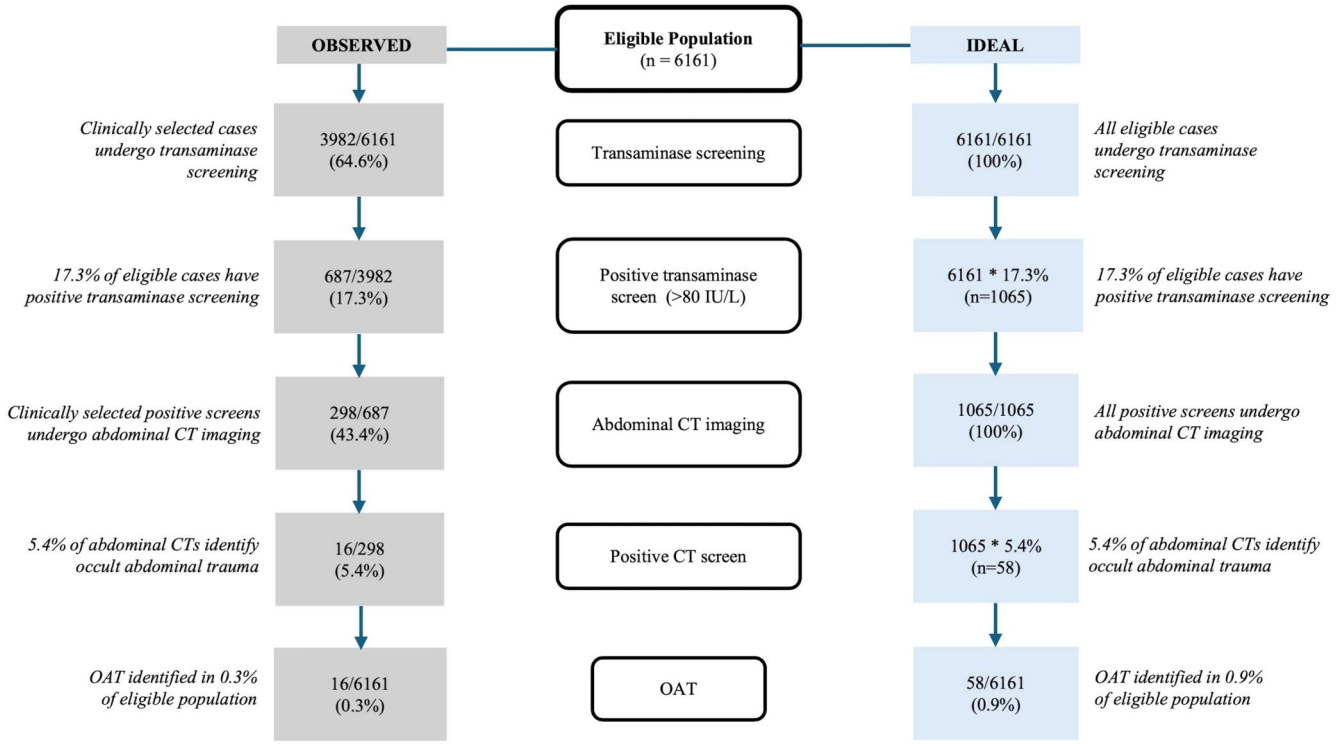

FIGURE 4. Sensitivity analysis flow diagram. Ideal scenarios assume complete adherence to current recommendations of transaminase screening and subsequent abdominal CT imaging for screens greater than 80 IU/L. Observed scenarios establish the lower bound of the sensitivity analysis, whereas ideal scenarios establish the upper bound.
Abbreviations: CT, computed tomography; n, sample size; OAT, occult abdominal trauma.

imaged, or vice versa. Although this allows us to study our objective of provider practice, it limits the generalizability of our findings. To address this limitation, we used our prevalence results as conservative rates to drive our sensitivity analysis. This way, we encompassed the entire eligible population, establishing upper bounds for OAT screening assuming all eligible children undergo OAT screening and imaging as currently recommended. Second, in our data, there is a group of patients with unreported ethnicity and race that appear to have significant associations with screening and imaging, respectively. Because we do not know what these unreported race and ethnicity values are, we cannot adequately interpret this association. Although the lack of significant associations between ethnic and racial minority and transaminase screening or abdominal CT imaging in adjusted multivariable analysis is encouraging for ongoing advancement and increased awareness of the role of implicit bias in child abuse evaluations, the risk of disproportionate testing for occult injury based on patient race and ethnicity remains a well-recognized concern.[32] Therefore, it is possible that the estimated influence of race and ethnicity on provider practice reflected in our study is inaccurate given the number of cases with unreported ethnicity and race. Third, the timing of events during the evaluation is not documented within CAPNET, limiting our understanding of a provider's screening approach. It is possible that symptoms and signs of abdominal injury were only recognized after the abdominal injury was identified. Similarly, the specific timing during the evaluation when transaminase screening may have occurred cannot be determined with CAPNET data. OAT screening is likely to be incorporated into standard trauma and ED protocols in most of the CAPNET-affiliated clinical settings. As a result, we cannot identify whether obtained transaminases and CT imaging were recommended specifically by the consulting CAP or if they were obtained by providers prior to CAP involvement, such as ED or PICU providers, at the participating or referring centers. Finally, our study cannot distinguish whether identifying nonsurgical OAT provides critical diagnostic information for an examining CAP or is a key factor in child welfare or criminal determinations outside the hospital walls.

Conclusion

Current OAT evaluation practices vary significantly between academic centers, with providers often obtaining hepatic transaminase values but not abdominal CT. In our cohort, OAT was an uncommon finding without clinical importance in children aged younger than 60 months presenting with injuries that prompted

evaluation for physical abuse, suggesting that routine transaminase screening in suspected child physical abuse evaluations may not be necessary when all signs and symptoms of abdominal injury are absent. Thus, CAP providers should remain judicious when recommending OAT evaluations. As this study did not aim to determine the utility of the currently recommended 80-IU/L transaminase cutoff value, future studies assessing the utility of both current and more judicious transaminase thresholds for children without signs or symptoms of abdominal trauma may be helpful, as would further study of clinical and historical elements that would lead to more effective targeted screening. Examining the significance of OAT and its influence on the diagnosis of child physical abuse may help guide efforts toward balancing the associated risk-benefit ratio and establishing consensus regarding the overall utility of OAT evaluation.

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