Presence of Microscopic Hematuria Does Not Predict Clinically Important Intra-Abdominal Injury in Children

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Objective: Screening for blunt intra-abdominal injury in children often includes directed laboratory evaluation that guides need for computed tomography. We sought to evaluate the use of urinalysis in identifying patients with clinically important intraabdominal injury (*ci*-IAI).

Methods: A retrospective chart review was performed for all patients less than 18 years who presented with blunt mechanisms at a level I trauma center between 2016 and 2019. Exclusion criteria included transfer from an outside facility, physical abuse, and death within thirty minutes of arrival. Demographics, physical exam findings, serum chemistries, urinalysis, and imaging were reviewed. Clinically important intraabdominal injury was defined as injury requiring ≥2 nights admission, blood transfusion, angiography with embolization, or therapeutic surgery.

Results: Two hundred forty patients were identified. One hundred sixty-five had a completed urinalysis. For all patients an abnormal chemistry panel and abnormal physical exam had a sensitivity of 88.9% and a negative predictive value of 99.3%. Nine patients had a *ci*-IAI. Patients with a *ci*-IAI were more likely to have abdominal pain, tenderness on exam, and elevated hepatic enzymes. When patients were stratified by the presence of an abnormal chemistry or physical exam with or without microscopic hematuria, urinalysis did not improve the ability to identify patients with a *ci*-IAI. In fact, presence of microscopic hematuria increased the rate of false positives by 12%.

Conclusions: Microscopic hematuria was not a useful marker for *ci*-IAI and may lead to falsely assuming a more serious injury.

Key Words: blunt abdominal trauma, trauma, intra-abdominal injury

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The significance of microscopic hematuria following blunt abdominal trauma in pediatric patients is not well established. Hematuria is a known marker of genitourinary injury, though nonspecific, and can also indicate nonurinary injury as well.[1,2] There remains debate whether microscopic hematuria should be an indication for further evaluation of intra-abdominal injury (IAI) in children such as axial imaging.[3]

While computed tomography (CT) is the imaging standard in the diagnosis of intra-abdominal injuries, risks of ionizing radiation in pediatric patients warrant selective use. For this reason, screening algorithms that guide clinical decision making and CT use have been implemented at many pediatric centers. These algorithms use complete laboratory panels, including markers of specific solid organ injury. Individually each study has not consistently performed well to screen for injury[4]; however, combined these studies have improved screening and predictive ability.[5] There is significant variability by institution in screening algorithms used to evaluate for blunt IAI, including the use of a urinalysis.[6]

Imaging was historically advocated for any degree of hematuria in children because of a higher risk for renal injuries due to larger relative size and lower position of the kidneys within the abdomen.[3,7] Furthermore, congenital renal anomalies or tumors can further predispose to injury, though rare.[8] Microscopic hematuria, however, is a poor predictor of congenital anomalies.[1] Current joint recommendations by the American Association for the Surgery of Trauma and the World Society of Emergency Surgery specify indication for CT only in the setting of an abnormal hematocrit in children with any degree of hematuria.[9] However, the significance of asymptomatic microscopic hematuria remains debated as its presence rarely requires intervention.[10] The purpose of this study was to determine whether the addition of urinalysis improved diagnostic accuracy for predicting clinically important IAI in pediatric blunt trauma patients. We hypothesized that microscopic hematuria does not improve the ability to identify clinically important IAI.

METHODS

Study Design and Patient Population

A retrospective chart review was conducted for patients who presented with blunt mechanisms of injury at a single, level I pediatric trauma center. Medical records were reviewed for all level I or level II trauma activations in patients less than 18 years of age from 2016 to 2019. Patients were excluded if they were transferred from an outside hospital, if they were evaluated for physical abuse, and if they died within 30 minutes of arrival. The study protocol was approved by the institutional review board (IRB #1911997501).

Trauma Activation Criteria

Trauma activation level followed the recommended criteria by the American College of Surgeons Committee on Trauma with level I activations determined by physiologic criteria or traumatic amputations and level II criteria determined by mechanism of injury.

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TABLE 1. Patient Characteristics

	Patients With UA (*n* = 165)	Patients Without UA (*n* = 75)	*P* Value
Age (years)	9.49	8.15	*P* = 0.07
Sex (% male)	68.0%	72.1%	*P* = 0.52
Race and ethnicity			
- White	9.3%	9.1%	*P* = 0.78
- Black	43.6%	43.6%	*P* = 0.95
- Asian	1.8%	2.7%	*P* = 0.65
Hispanic ethnicity	35.2%	36.0%	*P* = 0.89
Level I alert (%)	6.7%	8.0%	*P* = 0.52
Level II alert (%)	93.3%	92.0%	
Mechanism of injury			
- Auto vs. pedestrian	55.2%	57.3%	*P* = 0.78
- MVC	16.4%	5.3%	*P* = 0.02*
- Fall	20.0%	36.0%	*P* = 0.01*
- Assault	2.4%	1.3%	*P* = 0.57
- Bicycle	0%	2.0%	*P* = 0.85

MVC indicates motor vehicle collision.

Variables and Outcomes

Data collected included patient demographic information, mechanism of injury, clinical symptoms, vital signs at presentation, physical examination findings, laboratory data, injury, and radiographic findings. The primary outcome was the presence of a clinically important IAI, *ci*-IAI. An abdominal injury was defined as clinically important if patients required ≥2 nights admission, if they received blood or blood products, or if they required therapeutic angioembolization or surgery.

Statistical Analysis

Descriptive statistics were generated with mean and standard deviation or percentages for continuous and categorical variables, respectively. Comparisons between groups were analyzed using *t* test and χ^2 test for continuous and categorical variables, respectively. Bayes theorem was used to calculate the sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratios for all abnormal physical exam findings, and/or abnormal liver enzymes and lipase. These values were determined with and without microscopic hematuria as an added test. Microscopic hematuria was defined as >3 red blood cells per high powered field. True negative was defined as normal physical exam findings, hepatic enzymes, and lipase without a *ci*-IAI. A false positive was defined as presence of any abnormal examination findings or elevated hepatic enzymes, or lipase without a *ci*-IAI. A receiver-operating characteristic (ROC) curve was generated to determine the ability of the addition of microscopic hematuria to discriminate *ci*-IAI with the true-positive rate on the y-axis and the false-positive rate on the x-axis. All the tests were 2-sided and a *P* value of <0.05 was considered statistically significant. Analyses were performed using SPSS Version 28 (Armonk, NY: IBM Corp).

RESULTS

There were 240 patients who presented for blunt trauma during the study period. Most of the patients were male sex, and most were Hispanic ethnicity or Black race. Over 90% presented as a level II trauma activation. The most common mechanism of injury was pedestrian struck by a vehicle, and the second most common mechanism was fall. One hundred sixty-five patients had a urinalysis (UA) completed as part of their evaluation for blunt abdominal trauma. Patients who presented following a motor vehicle collision were more likely to have a UA completed. Patient characteristics and demographics are listed in Table 1.

There were nine patients with a *ci*-IAI. These included renal, hepatic, splenic, small bowel, and adrenal injuries. All but one patient had more than one injury. Two patients underwent laparotomy. One patient had both a laparotomy for a grade 4 hepatic injury and renovascular embolization. One patient required a blood transfusion and had a prolonged admission. The remaining five patients required greater than 2 nights admission for monitoring.

Presence of a *ci*-IAI stratified by whether patients had a urinalysis is depicted in Figure 1. Of the 165 patients who had a UA, 45 were found to have microscopic hematuria. Only two patients with microscopic hematuria had a *ci*-IAI. Of the 120 patients with a normal UA, three had a *ci*-IAI. There were four patients with a *ci*-IAI who did not have a UA as part of their work-up. For these four patients, injury was identified by physical exam or abnormal hepatic or pancreatic enzymes.

Test characteristics are listed in Table 2. Fifty-five percent of the patients were classified as true negatives. The true-negative rate decreased by 12% with urinalysis added to screening criteria. The false-positive rate increased with the addition of microscopic hematuria as an added criterion. The ROC curve demonstrated an area of 0.681 for abnormal physical exam findings, hepatic enzymes, or lipase in discriminating *ci*-IAI (Fig. 2). The area under the curve decreased to 0.619 with microscopic hematuria as an added criterion.

DISCUSSION

We evaluated whether urinalysis improved predictive ability for clinically important IAI. We found that urinalysis as an added test for IAI resulted in more false positives without identifying more *ci*-IAI. All children with *ci*-IAI had either abnormal findings on physical exam or abnormal liver function tests or pancreatic enzymes. No child with a *ci*-IAI had isolated microscopic hematuria.

Several studies have demonstrated that in the absence of other clinical findings, no intra-abdominal injuries were identified in children with asymptomatic hematuria alone.[2,11–13] These studies similarly distinguished significant injuries and insignificant or minor injuries although not all injuries required intervention.

Microscopic hematuria is a common finding in patients after blunt abdominal trauma. In our patient population, 27% of the patients with a UA had microscopic hematuria. Microscopic hematuria has been found in as high as 59% of patients after blunt abdominal trauma.[14] It is also relatively common in children at moderate risk for abdominal injury who have a normal mental status without findings of abdominal tenderness after blunt trauma.[15] Holmes and colleagues found a significant association between

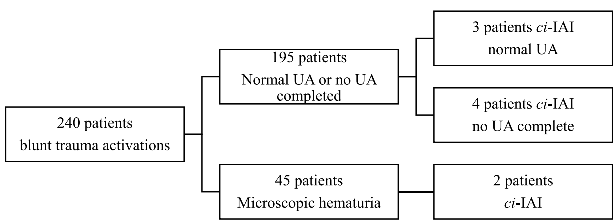

FIGURE 1. Presence of *ci*-IAI categorized by UA results. Most patients with *ci*-IAI had a normal UA or no UA completed.

TABLE 2. Test Characteristics for Abnormal Physical Exam and Laboratory Studies for Identifying *Ci*-IAI

Variable	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Positive Likelihood Ratio	Negative Likelihood Ratio
Abnormal blood test or physical exam finding	0.800	0.563	0.055	0.989	1.83	0.36
Abnormal blood test or physical exam finding (+) Hematuria	0.800	0.438	0.043	0.986	1.42	0.46

microscopic hematuria and IAI in children at moderate risk.[15] However, nearly 13% of their patients had microscopic hematuria while less than 2% had microscopic hematuria and an IAI.[15] In children with isolated microscopic hematuria, the likelihood of identifying a significant injury on imaging is low. In a meta-analysis of 796 children with microscopic hematuria, only 4% had grade 2 or higher renal injuries.[8] Microscopic hematuria may be frequently observed after blunt abdominal trauma due to forces that can cause renal capillary disruption without associated radiographic evidence of injury.[2]

Most notably, in our patient population, microscopic hematuria resulted in a higher false-positive rate. Microscopic hematuria is not a good predictor of *ci*-IAI. We strictly defined abdominal injuries based on the need for intervention. This is an important distinction between our study compared to others who have found a significant association between injury and microscopic hematuria.[15–17] These other studies identified microscopic hematuria as an independent predictor of IAI broadly defined to include any injury regardless of need for intervention. Very few patients with grade 1 or grade II solid organ injuries require intervention questioning the significance of identifying these injuries on imaging.[18,19]

We questioned the utility of microscopic hematuria in the evaluation of pediatric blunt abdominal trauma patients in our continued effort to optimize the care of our patients. Collection of a sample for urinalysis can often be delayed while awaiting patients to spontaneously void to limit unnecessary straight catheterization. We found that microscopic hematuria did not improve our ability to capture patients with a *ci*-IAI. It is a common, transient finding in patients who present with blunt mechanisms of injury, and the degree of microscopic hematuria has not been consistently associated with severity of injury.[20] In a child without abdominal tenderness and with no other indications for evaluation, microscopic hematuria can lead to added work up and in many cases does not change patient management.[10] We no longer use urinalysis in the evaluation of our patients after blunt trauma.

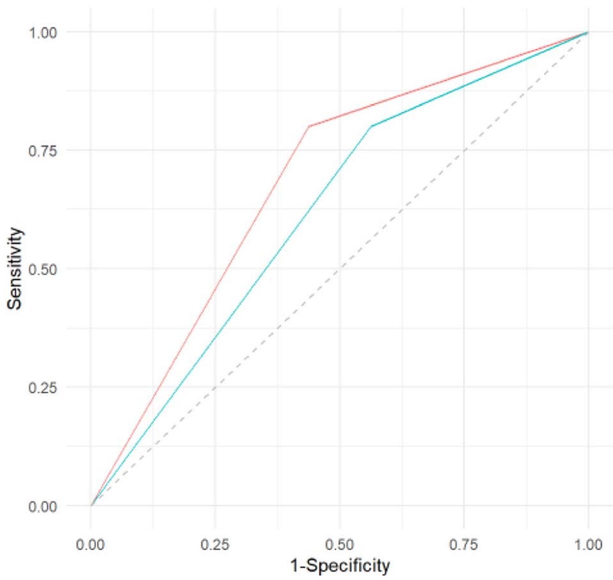

FIGURE 2. Area under the ROC curve for abnormal physical examination or abnormal laboratory results (red line) decreased with urinalysis as an additional test (blue line).

Our study is limited by its retrospective nature and small sample size. We were unable to confirm whether microscopic hematuria influenced patient management. Although data was not complete for all patients, nearly 70% of our patients had a UA completed. There was no long-term follow-up information for our patients after 30 days, but there were no missed injuries within this period.

CONCLUSIONS

The results of our study demonstrate that microscopic hematuria was not a useful marker for clinically important IAI in our patient population. The routine use of urinalysis in the evaluation of pediatric blunt abdominal trauma should be reconsidered.

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