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Pediatric trauma primary survey performance among surgical and non-surgical pediatric providers in a Brazilian trauma center

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ABSTRACT

Introduction Trauma is the leading cause of death and disability among Brazilian children and adolescents. Trauma protocols such as those developed by the Advanced Trauma Life Support course are widely taught, but few studies have assessed the degree to which the use of protocolized trauma assessment improves outcomes. This study aims to quantify the adherence of trauma assessment protocols among different types of frontline trauma providers.

Methods A prospective observational study of pediatric trauma care in one of the busiest Latin American trauma centers was conducted during 6 months. Trauma primary survey assessments were observed and adherence to each step of a standardized primary assessment protocol was recorded. Adherence to the assessment protocol was compared among different types of providers, the time of presentation and severity of injury. The relationship between protocol adherence and clinical outcomes including mortality, length of hospital stay, admission to pediatric intensive care unit, use of blood components, mechanical ventilation and number of imaging exams performed in the first 24 hours were also assessed.

Results Emergency department evaluations of 64 patients out of 274 pediatric admissions were observed over a period of 6 months. 50% of the primary assessments were performed by general surgeons, 34.4% by residents in general surgery and 15.6% by pediatricians. There was an average adherence rate of 34.1% to the trauma protocol. Adherence among each specific step included airway: 17.2%; breathing: 59.4%; circulation: 95.3%; disability: 28.8%; exposure: 18.8%. No differences between specialties were observed. Patients with a more thorough primary assessment underwent fewer CT scans (receiver operating characteristic curve area: 0.661; p=0.027).

Conclusions Our study demonstrates that trauma assessment protocol adherence among trauma providers is low. Thorough initial assessment reduced the use of CT scans suggesting that standardized pediatric trauma assessments may be a way to reduce unnecessary radiological imaging among children.

Level of evidence IV.

Study type Pediatric and global trauma.

INTRODUCTION

Trauma is the leading cause of death among Brazilian children over the age of 1, with approximately 4000 deaths annually in children between the ages of 1 and 14.[1 2]

Access to high-quality trauma care is essential to reduce child mortality, yet trauma remains a neglected disease worldwide.[3 4] Even in the USA, which has a well-organized system of pediatric trauma centers, 17.4 million children and adolescents under the age of 15 face barriers in access to pediatric trauma centers.[5] These barriers are compounded by additional delays in low-income and middle-income countries (LMICs) where there are limited numbers of specialized trauma centers, which in turn provide care for vast populations resulting in geographic and transfer-related delays in trauma care.[6–8] Ensuring that a basic level of pediatric trauma care can be provided at non-specialized centers has become a recommended strategy to improve access to trauma care worldwide.

Efforts to ensure that trauma care can be delivered in rural settings were initiated in the USA in 1978 when the Advanced Trauma Life Support course (ATLS) was introduced as a way to standardize trauma assessment in rural settings. ATLS has since expanded to over 60 countries, including Brazil and has become recognized as a gold standard for trauma assessment and education. It is also recognized as a tool to improve trauma outcomes.[9 10] Despite the widespread availability of ATLS training, pediatric trauma center providers often have poor adherence to the ATLS protocol.[11]

In Brazil, the majority of pediatric trauma care takes place in hospitals that do not have pediatric surgical specialists. In addition, not all pediatric specialists are trained in trauma. Trauma centers are clustered in major cities, resulting in a lack of access to specialized trauma care for countryside.[2 11] Thus, the majority of initial trauma care occurs at smaller centers where initial assessment represents the first point of contact for pediatric trauma providers and a chance to optimize care and improve outcomes. Although improvement in trauma assessment knowledge through coursework has been shown to increase provider confidence, there are few studies linking this confidence to clinical outcomes.[9 12 13] These studies recognized the importance of evaluating local trauma care, using different strategies (cameras, simulations, medical record review).

In this study, we aim to assess the quality of primary trauma assessment among different frontline providers by evaluating the proportion of steps completed on a standard trauma assessment protocol and determine if improved primary assessment quality is associated with improved clinical outcomes.

METHODS

Objectives

The main objective of the study is to evaluate quality of pediatric primary assessment through evaluation of the adherence of health providers to essential steps of trauma assessment protocols. The secondary objective is to determine if a higher adherence to trauma protocols is associated with better clinical outcomes including length of stay, mortality, use of imaging exams, admissions to the intensive care unit, use of blood components and initiation of mechanical ventilation.

Settings and participants

This is a prospective observational cohort study. Patients were enrolled over a 6-month period from October 2017 to March 2018 at Hospital João XXIII (HJXXIII). HJXXIII is a large tertiary trauma hospital with over 12 000 combined adult and pediatric trauma admissions per year. It was once elected the best Brazilian trauma hospital and it is considered one of the busiest trauma centers in Latin America. HJXXIII is the trauma hospital referral center for 20 million Brazilians. Trauma care is typically provided by surgical providers, but pediatricians also attend to pediatric trauma care depending on provider availability. The time to initiate a pediatric trauma assessment in HJXXIII is usually around 2 min.

Patients were included in the study if they were aged 14 years or less, assessed in the trauma bay by a general surgeon, general surgery resident or general pediatrician and classified as emergent or very urgent by the Manchester Protocol.[14] The Manchester Protocol is an international triage system used to classify emergent patients at the time of admission and has been adopted by most public and private hospitals in Brazil. The Manchester Protocol identifies patients who should be prioritized for care through condition-specific flow charts. Based primarily on vital signs values and mechanism of trauma, patients are classified into one of five different groups: red (emergent), very urgent (orange), urgent (yellow), green (slightly urgent) and blue (non-urgent). Red patients should be treated immediately. Orange in 10 min, yellow in an hour. Green patients should be treated in 2 hours. Blue patients can be referred to primary health facilities or wait until the other priorities.

Informed consent to observe the initial trauma assessment was obtained from all providers. Consent for patients was waived since this study was purely observational and the anonymity of the patients was preserved. Exclusion criteria consisted of any one of the following: age >14 years; Manchester classification of blue, green or yellow; non-trauma diagnosis or patient assessed by other specialty such as neurosurgeon or plastic surgeon. These specialties were excluded as usually they receive patients transferred from other services within hours (even days) after trauma and made up very few of the total number of assessments performed.

Sample size

Sample size was calculated a priori based on the hypothesis that 80% of professionals would not adhere fully to the protocol with a margin of error of 10%. Based on this, an estimated sample size number of 62 patients was calculated at a 95% confidence level.

Data collection and variables

The study staff consisted of senior medical students trained to use a standard checklist of trauma assessment. A pilot study was conducted over 2 weeks prior to the start of the study in order to observe trauma observations and ensure that the checklist was implemented in a similar way by all researchers regardless of level of training. Review of the checklists was performed by a pediatric surgeon to assess inter-rater reliability (online supplementary file 1).

Study staff were assigned to observe trauma admissions for one-third of all trauma shifts during the study period. They were assigned in different shifts, every day of the week. Study staff observed in an independent manner and were not part of the patient care team. Providers were aware of the study and aware of the fact that researchers were present in the trauma bay. All electronic medical records were later reviewed for additional study variables. Finally, the study staff checked all data and all electronic medical records looking for errors to ensure data quality. Providers were categorized into three distinct groups: general surgeons (those with board certification in general surgery), surgical residents (those in the last year of surgical residency training) and general pediatricians who perform the initial

Table 1 Trauma assessment steps—evaluated by the main researcher

	Criteria	Failure
Airway	A.1 Protection of cervical spine (either manual stabilization or application of cervical collar)	Observer did not observe cervical protection.
	A.2 Deliver oxygen if respiratory rate or oximetry were abnormal	No use of oxygen when the patient had abnormal RR.
Breathing	B.1 Measurement of respiratory rate	No RR was verbalized during initial assessment or written in medical record.
	B.2 Immediate treatment for open pneumothorax, tension pneumothorax, massive hemothorax or flail chest	No chest tube insertion in a patient with a written diagnosis of open pneumothorax, tension pneumothorax, massive hemothorax. No offer of oxygen in a patient with a written diagnosis of flail chest.
Circulation	C.1 Measurement of heart rate	No HR verbalized by the provider, or displayed or written in medical record.
	C.2 Initiation of intravenous fluids if tachycardia, hypotension or abnormal capillary refill	Fluids were not initiated in a patient with abnormal vital signs (HR, BP, ACR).
Disability	D.1 Evaluation of GCS	No GCS verbalized or written in medical record.
Exposure	E.1 Examination of patient's back	No examination of patient's back.
	E.2 Protection against hypothermia	Provider did not cover patient with his/her clothes after assessment.
Other	O.1 Measurement of weight or use of Broselow tape	No weight verbalized or written in medical record; no use of Broselow tape.

ACR, abnormal capillary refill; BP, blood pressure; GCS, Glasgow Coma Score; HR, heart rate; MV, mechanical ventilation; RR, respiratory rate.

Features	Patients
Age (years)	7.3±4.1 (8.0)
Gender	
Female	23 (35.9)
Male	41 (64.1)
Mechanism of trauma	
Falls	26 (40.6)
MVC	13 (20.3)
Struck by vehicle	12 (18.7)
Bicycle crash	7 (10.9)
Burns	2 (3.2)
Penetrating trauma	1 (1.6)
Others	3 (4.7)
Shift	
Morning	12 (18.7)
Evening	33 (51.6)
Night	19 (29.7)

Table 2 Description of gender, mechanism of trauma, shift and age

Absolute numbers, percentage in parentheses. Except for age; represented by mean, SD and median.
MVC, motor vehicles accident.

trauma assessment for pediatric patients. All assessments were performed by one of these three types of providers and a nursing assistant. In HJXXIII, as is the case in many Brazilian hospitals, primary assessment is usually performed by a single physician and not by a team, due to high volume of cases.

Our primary outcome was trauma assessment thoroughness, which was defined as the percentage of components evaluated across five core assessment domains aligned with the ATLS protocol, previous studies and HJXXIII protocols.[15 16] These included formal assessment of airway, breathing, circulation, disabilities and exposure (*ABCDE*) (table 1). The research team observed how many of the steps selected were performed for each trauma patient assessed (table 1). These steps were chosen based on the criteria that they are considered essential, as they address initial treatment or increase suspicion for the main causes of immediate deaths from trauma. The following steps were selected: protection of C-spine; oxygen delivery for patients with respiratory distress; chest tube insertion for patients with hypertensive pneumothorax, massive hemothorax and open pneumothorax; fluids for patient with shock. They also considered essential steps: Glasgow Coma Scale (GCS) calculation, as it is an important exam to diagnose head trauma; examination of the patients back and protection from hypothermia. Finally, weight assessment was considered fundamental as providers need to know patient's weight to understand their vital signs and to treat them.

It is very important to note that researchers responsible for collecting the data were not responsible for diagnosing the conditions mentioned. In the end, the main researcher read all medical records and classified the steps as adequate or not as mentioned in table 1. It is also important to note that the goal was not for providers to achieve 100% on the assessment steps as some steps may not apply to all patients.

Additional variables were collected including age, gender, trauma score (*Revised Trauma Score and Pediatric Trauma Score*), mechanism of injury and time of assessment (morning (07:00 to 13:00 hours), afternoon (13:00 to 19:00 hours) and evening (19:00 to 24:00 hours). Data from midnight to 07:00 were not collected because the number of admissions during this period of time is low and because it is not safe for researchers to stay late at night.

Secondary outcomes were defined as: (1) use of imaging study (in the first 24 hours) such as X-rays or ultrasonography or CT scan; (2) admission to pediatric intensive care unit (PICU); (3) GCS; (4) need for definitive airway (mechanical ventilation); (5) blood transfusion; (6) death and (7) length of stay (time from hospital admission until discharge).

We used the following criteria to define significant injury: GCS <15, need for airway intervention, hospitalization (ward or PICU), shock, need for CT scan, immediate surgery or death.[17]

Table 3 Patient demographics and clinical markers by specialty

		Specialty			
Characteristics	Total	Surgeon	Resident	Pediatrics	P value
Total patients (n)	64 (100.0)	32 (50.0)	22 (34.4)	10 (15.6)	
Age (years)	7.3±4.1	7.8±3.9	7.8±3.9	4.1±4	0.027[1]
Male gender	41 (64.1)	21 (65.6)	17 (77.3)	3 (30.0)	0.036[2]
GCS* (<15)	8 (13.1)	6 (19.4)	2 (9.1)	0	0.371[2]
CT scan	31 (48.4)	15 (46.9)	12 (54.5)	4 (40.0)	0.838[2]
Definitive airway	2 (3.1)	1 (3.1)	0	1 (10.0)	0.405[2]
Shock	7 (10.9)	4 (12.5)	1 (4.6)	2 (20.0)	0.308[2]
Immediate surgery	2 (3.1)	0 (0.0)	0	2 (20.0)	0.143[2]
Hospital admission	14 (23.0)	7 (24.1)	2 (9.1)	5 (50.0)	0.040[2]
PICU admission	3 (4.9)	0	0	3 (30.0)	0.003[2]
Death	0	0	0	0	–
Severe patients	38 (59.4)	20 (62.5)	12 (54.5)	6 (60.0)	0.887[2]

Statistical tests: 1—analysis of variance, 2—Fisher's exact test. Used when appropriate.
Descriptive results represented by absolute numbers and average in parentheses. Except for age represented by mean, and SD.
*Important note: results of patients that have GCS calculated.
GCS, Glasgow Coma Score; PICU, pediatric intensive care unit.

Analysis

The rate of trauma assessment adherence was compared among the three types of providers: surgeons, surgical residents and pediatricians. Additionally, the association between thoroughness of trauma assessment and hospital admission, admission to PICU, need for mechanical ventilation, blood transfusion and CT scan utilization were assessed.

Comparisons between patient characteristics and trauma assessment adherence were performed using Pearson's χ^2 test or Fisher's exact test (in cases with an expected frequency of <5). The associations were quantified by the OR and their respective 95% CIs. Comparisons between provider type were performed from the F-test (analysis of variance) when the assumptions of normality and homoscedasticity were satisfied and Kruskal-Wallis otherwise. Receiver operating characteristic (ROC) curves were constructed to evaluate the use of CT scan in relation to the percentage of adherence. Statistical analyses were performed in R V.3.2.5, MINITAB and PASW Statistics—SPSS V.18.

RESULTS

Two hundred seventy-four pediatric patients were admitted during the study period. Of these, 64 met study criteria, were admitted during one of the observed shifts and enrolled in the study. An additional five patients were excluded from the study, as they were not admitted or were assessed by another specialty.

Table 4 Adherence to the protocol and clinical outcomes by specialty

		Specialty			
Adherence	**Total**	**Surgeon**	**Resident**	**Pediatrics**	**P value**
Complete	0	0	0	0	–
A	8 (12.5)	3 (9.4)	5 (22.7)	0	0.191[1]
B	11 (17.2)	6 (18.8)	4 (18.2)	1 (10.0)	1.000[1]
C	38 (59.4)	20 (62.5)	11 (50.0)	7 (70.0)	0.513[1]
D	61 (95.3)	31 (96.9)	22 (100.0)	8 (80.0)	0.061[1]
E	12 (18.8)	3 (9.4)	4 (18.2)	5 (50.0)	0.019[1]
Vital data	1 (1.6)	0	0	1 (10.0)	0.156[2]
% adhesion	34.1	32.8	34.9	36.7	0.821[1]
Outcome					
Exams	2.3+1.7	2.6±1.7	2.5±1.4	1.1±1.9	0.013[3]
LOS (days)	2.6+8.0	0.7±1.7	1.0±4.7	11.4±16.3	0.112[3]
PICU (days)	0.6+3.1	0	0	3.7±7.1	–
Blood (units)	0.1+0.4	0	0	0.4±1.0	–
MV time (days)	0.1+0.9	0	0	0.7±2.2	–
Death	0	0	0	0	–

Statistical tests: 1—analysis of variance, 2—Fisher's exact test, 3—Kruskal-Wallis test.
Adherence column results represented by absolute number and mean in parentheses. Except for % adhesion. Per cent adhesion means average number of steps performed during primary survey.
Outcome column results represented by mean and SD.
ABCDE, trauma steps assessment (table 1); LOS, length of staying; MV, mechanical ventilation; PICU, pediatric intensive care unit.

Table 2 shows the demographic results. Of the 64 patients, 32 (50.0%) were assessed by a general surgeon, 22 (34.4%) by a general surgical resident and 10 (15.6%) by a pediatrician (table 3).

Pediatricians assessed younger children (p=0.027), predominantly females (p=0.036) and had a higher rate of hospitalization (p=0.040) and PICU admission (p=0.003).

Trauma assessment adherence rates ranged from 17.9% to 34.9% with no provider completing all steps of the initial assessment. Eight providers (12.5%) completely assessed the airway; 11 (17.2%) assessed breathing; 38 (59.4%) assessed circulation; 61 (95.3%) assessed disability; 12 (18.8%) examined the patients back; 1 (1.6%) assessed all vital signs (table 3).

Table 4 presents the comparisons between adherence to the assessment protocol and outcomes by specialty. There were no significant differences between specialties other than a significant increase in examination by pediatricians (p=0.019).

Protocol adherence differed by injury severity. In severely injured children there was lower overall adherence (p=0.010), lower adherence to steps A (p<0.001) and E (p=0.010) and more imaging studies (X-rays, ultrasonography and CT scans) performed (table 5). There were no significant differences between adherence and time of day.

Patients underwent 2.3 imaging exams on average during their trauma assessment. Pediatricians obtained fewer imaging studies per patient: 1.1, compared with general surgeons: 2.6 and surgical residents: 2.5 (p=0.019, table 4).

More imaging studies were performed in the most severely injured patients p<0.001 (table 5). There was also a correlation between the number of CT scans performed and the thoroughness of trauma assessment. The higher the protocol adherence, the lower the number of CT scans performed (ROC curve area 0.661, p=0.027).

DISCUSSION

Pediatric trauma and primary survey

To our knowledge, this is the first study to evaluate pediatric trauma assessment in an LMIC by different specialties in a standardized setting. Our primary findings show that despite ATLS training of surgeon providers, adherence to the recommended trauma assessment steps are similar to non-surgical providers and resident providers. Additionally, despite the prevalence of low adherence, it was observed that professionals that completed more trauma assessment steps ordered fewer CT scans, with no difference in mortality.

Differences among providers and adherence

Like most hospitals that treat pediatric trauma patients, HJXXIII predominantly provides adult trauma care.[2] We sought to determine if pediatric trauma assessment differed among the different types of providers who typically provide initial care in our hospital. Our findings demonstrate that there is no significant difference in the completion of the primary survey between general surgeons, surgical residents and pediatricians. Rates of completing the primary survey were low among all groups, even among the surgeons and general surgery residents who have been trained in ATLS and would be expected to perform better on trauma assessment than non surgical providers, especially at this hospital with a trauma team and a trauma surgery fellowship program. Hundred per cent of surgeons involved in the study are ATLS certified and only 33,3% of pediatricians are ATLS certified. The opposite is also true when providers were asked about Pediatric Advanced Life Support Course. Hundred per cent of pediatricians had completed the course and only 22.2% of surgeons had done it. This highlights a gap in pediatric trauma care where surgeons are training for trauma and pediatricians

Table 5 Protocol adherence according to severity and outcome of trauma patients, younger than 15 years between October 2017 and March 2018

	Severe patient		
Adherence	**Yes**	**Not**	**P value**
Complete	0	0	–
A	0	8 (30.8)	<0.001[1]
B	6 (15.8)	5 (19.2)	0.746[1]
C	22 (57.9)	16 (61.5)	0.771[2]
D	35 (92.1)	26 (100.0)	0.265[1]
E	3 (7.9)	9 (34.6)	0.010[1]
Vital data	1 (2.6)	0	1.000[1]
% adhesion	29.4	41.0	0.010[3]
Outcome			
Exams	3.0±1.7	1.3±1.1	<0.001[3]
LOS (days)	4.4±10.1	0	–
PICU (days)	1.0±4.0	0	–
Blood (bags)	0.1±0.5	0	–
MV time (days)	0.2±1.2	0	–
Death	0	0	–

Statistical tests: 1—Fisher's exact test; 2—Pearson's χ^2 test; 3—Student's t-test.
Adherence column results represented by absolute number and mean in parentheses. Except for % adhesion. Per cent adhesion means average number of steps performed during primary survey.
Outcome column results represented by mean and SD.
ABCDE, trauma steps assessment (table 1); LOS, length of staying; MV, mechanical ventilation; PICU, pediatric intensive care unit.

focus on pediatrics. That is probably the reason that 85.7% of the providers answered that a pediatric trauma care course is necessary.

We showed that a significant number of pediatric patients are assessed by non-surgical providers. Efforts to improve pediatric trauma assessment need to focus on all provider types, including those who regularly assess adult trauma patients. The lack of difference in assessment quality between provider groups during first assessment is in line with studies and recommendations suggesting initial pediatric trauma care could be provided by pediatric surgeons and non-surgical providers including pediatricians.[18] On average, only 34.1% of the primary assessment was completed. The lowest adherence rate was formal airway assessment (12.5%). This was primarily due to the lack of cervical immobilization in younger children and a lack of oxygen delivery in dyspneic patients. Low adherence was observed for breathing assessment (15.8%), mainly due to the lack of respiratory rate measurement. Low adherence was also noted for exposure (18.8%), mainly due to the lack of examination of the back. It is possible that providers relied on visual inspection of the child's respiratory pattern to define them as eupneic or dyspneic, without numeric measurement of the respiratory rate. The observed high adherence to heart rate measurement could be attributed to the routine use of monitors for the measurement of heart rate and blood pressure. Manually obtaining other vital signs in the pediatric population, such as heart rate and blood pressure has been described as challenging.[19] There was good adherence to GCS completion, possibly in part because it was typically scored 15.

In our study, a preference to leave the care of younger children to pediatricians (mean age in this group of 4.1 vs 7.8 years) was noted, which may also have led to more admissions to the hospital and the PICU, since the patients attended by pediatricians were more frequently hospitalized. However, it also led to fewer imaging studies being performed in those children. Other parameters of severity, such as CT scan, GCS <15, and shock were equally distributed among the groups and did not appear to contribute to any profession-based difference in care.

Protocol adherence, CT scan and severity

Unnecessary imaging studies are recognized as a major cause of delays to secondary transfer and definitive treatment.[7] There is also a concern about CT and radiation risks.[20]) Therefore, we chose number of imaging studies as an indicator of quality. In this study, higher protocol adherence was associated with a significant decrease in the use of CT scan. The use of screening CT is actively debated in trauma care, with some proposing its use in the initial evaluation, while others suggest selective CT scanning based on other findings.[21] A selective approach may be more feasible in countries with fewer resources, since CT scanning in such places can be very expensive or unavailable and the older scanners available deliver higher doses of radiation.[11,22] More research is needed to determine if this association is due to improved assessment alone or also due to increased severity among these patients as we were not powered to adjust for confounders among our secondary outcomes.

We also observed a lower rate of primary survey completion in critically injured patients, associated with a higher number of imaging studies (X-rays, CT scans, ultrasonography) performed (table 5). The reasons for this are not certain, but providers may be using the imaging exams as a substitute for the physical exam. Additionally, patients treated by pediatricians underwent fewer imaging tests, perhaps secondary to greater confidence in pediatric physical examination, since non-pediatric professionals may feel less confident in their ability to evaluate younger children.[19,23]

Significance

To the authors' knowledge, this is the first prospective study about pediatric trauma protocols and quality of care in an LMIC. As Brazil is a middle-income country with vast regional disparities in acute surgical care, this setting is ideal for pediatric trauma studies with application to all resource settings, and especially to LMICs across the globe.

Limitations

This study has limitations. As a single institution study, our findings may reflect local practices and may not be generalizable to other country settings. Additionally, the use of a checklist to assess the quality of primary assessment that was used in this study has not been validated; however, it was based on the most widely used assessment tool taught across the globe.

Data were collected by trained student observers; however, we were unable to use different designs for data collection (eg, in Brazil, the use of cameras in the trauma bay is not allowed by Brazilian Ethical Council). For these reasons, we decided to use medical students, as they are the most neutral researchers available that would know how to collect data and in the same way with less interference in the provider's assessment. In the end, the main researchers reviewed all data and medical records post hoc to assure quality of data.

We were not powered for our secondary outcomes due to the low number of patients included and thus our assessment of clinical outcomes is hypothesis generating. Nonetheless, we believe this is an important step toward understanding the tangible clinical benefits that could accompany investment in improved trauma training and assessment between CT and protocol adherence or differences among specialties. Despite this, we believe that the results are important as they encourage us to develop new projects in order to better understand these associations. This also reinforces how general indicators such as mortality and length of stay can be inappropriate to assess institutional quality of pediatric trauma care.

CONCLUSION

Evaluation of ATLS-defined components of the trauma primary assessment demonstrates that despite being trained in ATLS, initial assessment quality is low for both surgical and non-surgical providers. Children with the highest injury severity were the least likely to undergo a full assessment and also underwent the highest level of CT imaging. There is an urgent need to organize pediatric trauma systems through improved triage and training of providers and initial training with trauma certifications may not result in high-quality initial assessment.

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Patient consent for publication Not required.

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under number 094B/2017. It was also approved by the BCH Research Ethics Committee, number P00031402.

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