Journal of Pediatric Surgery 56 (2021) 146–152

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Trauma

Surgeon choice in management of pediatric abdominal trauma☆

Elissa K. Butler [a,b,c,*], Jonathan I. Groner [d,e], Monica S. Vavilala [a,f], Eileen M. Bulger [a,b], Frederick P. Rivara [a,g]

[a] Harborview Injury Prevention & Research Center, University of Washington, 325 9th Ave Box 359960, Seattle, WA 98122, USA
[b] Department of Surgery, University of Washington, 1959 NE Pacific Street, WA 98195, USA
[c] Department of Surgery, SUNY Upstate Medical University, 750 East Adams Street, Syracuse, NY 13210, USA
[d] Center for Pediatric Trauma Research, Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH 43205, USA
[e] Department of Pediatric Surgery, Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH 43205, USA
[f] Department of Anesthesiology & Pain Medicine, University of Washington, 1959 NE Pacific St, Seattle, WA 98195, USA
[g] Department of Pediatrics, University of Washington, 1959 NE Pacific St, Seattle, WA 98195, USA

ARTICLE INFO

Article history:
Received 21 September 2020
Accepted 23 September 2020

Key words:
Abdominal trauma
Hollow viscus injury
Children
Surgeon type
Non-operative management
Laparoscopy

ABSTRACT

Background: No guidelines exist for management of hemodynamically stable children with suspected hollow viscus injury. We sought to determine factors contributing to surgeon management of these patients.
Methods: Surgeon members of the Eastern Association for the Surgery of Trauma and American Pediatric Surgical Association completed a survey on 3 blunt abdominal injury scenarios: (1) isolated, (2) with multisystem injury, and (3) with traumatic brain injury (TBI), and a penetrating injury scenario. Multivariable logistic regression was used to determine factors associated with initial management of observation vs. operation for blunt injury and observation vs. local wound exploration versus laparoscopy for penetrating injury.
Results: Of 394 surgeons (response rate 22.3%), 50.3% were pediatric surgeons. For scenarios 1–3, 32.2%, 49.3%, and 60.7% of surgeons chose operation over observation, respectively. Compared to isolated blunt injury, surgeons were more likely to choose operation for patients with multisystem injury (aOR 2.20, 95%CI: 1.78–2.72) or TBI (aOR 3.60, 95%CI: 2.79–4.66). Pediatric surgeons were less likely to choose operation (aOR 0.32, 95%CI: 0.22–0.44). For penetrating injury, 39.1%, 29.5%, and 31.5% of surgeons chose observation, local wound exploration, and laparoscopy, respectively.
Conclusions: Large variation exists in management of hemodynamically stable children with suspected hollow viscus injury. Although patient injury characteristics account for some variation, surgeon factors such as type of surgeon also play a role. Evidence-based practice guidelines should be developed to standardize care.
Type of Study: Cross-Sectional Survey.
Level of Evidence: N/A

© 2020 Elsevier Inc. All rights reserved.

The majority of abdominal trauma in children is managed non-operatively [1]. However, in the hemodynamically stable patient with concerning physical exam findings and/or equivocal imaging, such as free fluid without solid organ injury, surgeons must be concerned for hollow viscus injury [2]. They must choose between close observation with serial abdominal exams, diagnostic laparoscopy, or exploratory laparotomy. There are no established evidence-based criteria to guide decision making for adults or children in this scenario.

Historically, all suspected hollow viscus injuries were investigated via laparotomy [3], but several more recent studies in adults have advocated for a period of non-operative management to avoid non-therapeutic laparotomies [4–8]. Non-operative management may result in delayed diagnosis of a hollow viscus injury leading to unnecessary morbidity and potential mortality [9,10]. Observation of children with suspected hollow viscus injury may be less feasible due to the potentially unreliable history and physical examination [11].

Operative intervention may be required to diagnose and manage non-hemorrhagic abdominal injuries, particularly hollow viscus injuries [12,13]. Although laparotomy remains the gold standard in management of abdominal trauma, the use of laparoscopy, both in adults and children, has steadily increased [14–16]. Laparotomy confers an increased long-term risk of bowel obstruction and abdominal wall hernias; however, it is often perceived as faster, more cost-effective, and more accurate [17]. Laparoscopy has the potential to prevent non-therapeutic laparotomies, avoid a large scar, and reduce pain and risk of bowel obstruction and incisional hernias; but surgeons and trainees may feel unprepared to treat traumatic injuries laparoscopically [12,14,17,18]. In an analysis of operative management of 620 hemodynamically stable children with blunt abdominal trauma in the National

Abbreviations: APSA, American Pediatric Surgical Association; EAST, Eastern Association for the Surgery of Trauma; TBI, Traumatic brain injury.

☆ Funding sources: Dr. Butler was supported by the National Institutes of Health T-32 Pediatric Injury Research Training Program [5T32HD057822-10].

* Corresponding author at: SUNY Upstate Medical University, 750 East Adams Street, Syracuse, NY 13210, USA.
E-mail address: butlere@upstate.edu (E.K. Butler).

https://doi.org/10.1016/j.jpedsurg.2020.09.023
0022-3468/© 2020 Elsevier Inc. All rights reserved.

Trauma Data Bank, 70% of patients underwent laparotomy and 30% underwent laparoscopy [19].

Given the variability in management of pediatric patients with abdominal trauma, we hypothesized that, in addition to patient factors, surgeon experience played a large role in choice of management. By surveying surgeons caring for children with abdominal trauma, we aimed to determine what patient, surgeon, and facility factors contribute to current practice in management of abdominal trauma in children.

1. Methods

1.1. Survey tool

The survey tool consisted of 5 clinical scenarios of a hemodynamically stable 9-year-old male with abdominal trauma without solid-organ injury and without a clear indication for an operation (Appendix A). The first three scenarios were (1) isolated blunt abdominal trauma, (2) blunt abdominal trauma with severe multisystem injury, and (3) blunt abdominal trauma with severe traumatic brain injury (TBI) requiring intubation. These scenarios asked the surgeon to choose observation with serial abdominal exams and/or serial labs, diagnostic laparoscopy, or exploratory laparotomy. If the surgeon chose observation, the scenario progressed to the patient developing peritoneal signs after 12 h and the surgeon was asked to choose diagnostic laparoscopy or exploratory laparotomy as the next step in management. Participants were then asked to select all the reasons for their decision of laparoscopy or laparotomy. The fourth scenario was a 9-year-old male stab wound to the abdomen. Surgeons were asked to choose between observation with serial abdominal exams and/or serial lab exams, diagnostic laparoscopy, exploratory laparotomy, or local wound exploration. The fifth scenario was a 9-year-old male with isolated blunt abdominal trauma who was taken to the operating room for diagnostic laparoscopy. The surgeon was asked to select all reasons for converting to an open operation. After completion of the case scenarios, participants were asked to provide information about their training and the main facility in which they practice.

The survey tool was piloted among two adult trauma and pediatric surgeons who provided feedback on question and answer choice clarity. The questionnaire took an average of 8 min to complete. The survey was administered and study data were managed using REDCap electronic data capture tools hosted at the University of Washington Institute of Translational Health Sciences. The tool was tested on both desktop and phone browsers to assess usability and readability.

1.2. Study participants

The survey was distributed via email to active and senior members of the Eastern Association for the Surgery of Trauma (EAST) and regular and associate members of the American Pediatric Surgical Association (APSA). Eligible participants were adult or pediatric surgeons who care for injured children (age <15 years) with abdominal trauma. Current trainees (medical students, residents, or fellows) and participants who did not complete the survey were excluded. If surgeons received invitations to participate from both organizations, they were asked to

Table 1
Characteristics of 394 surgeons caring for pediatric patients with abdominal trauma.

	All n = 394	Trauma surgeon n = 194	Pediatric surgeon n = 198
Years in practice	12 (5–21)	10 (4–20)	15 (8–23)
Abdominal cases per year	200 (133–315)	200 (125–300)	223 (150–320)
Proportion of cases performed laparoscopically	60.0 (50.0–72.7)	50.0 (39.0–66.6)	66.6 (50.0–79.2)
Proportion of cases performed for trauma	7.5 (2.7–27.3)	26.6 (12.2–41.7)	2.7 (1.3–5.0)
Adult trauma level designation			
Level I	263 (67.1)	144 (74.2)	119 (60.7)
Level II	67 (17.1)	44 (22.7)	22 (11.2)
Level III-IV	9 (2.3)	6 (3.1)	2 (1.0)
No designation	53 (13.5)	0 (0.0)	53 (27.0)
Pediatric trauma level designation			
Level I	182 (46.3)	51 (26.3)	131 (66.5)
Level II	97 (24.7)	53 (27.3)	44 (22.3)
Level III-IV	11 (2.8)	3 (1.6)	8 (4.1)
No designation	103 (26.2)	87 (44.9)	14 (7.1)
Hospital type			
Academic medical center	246 (63.4)	99 (51.6)	147 (75.8)
Community teaching hospital	116 (29.9)	75 (39.1)	41 (21.1)
Non-teaching hospital	26 (6.7)	18 (9.4)	6 (3.1)
Proportion of admitted patients pediatric	13.0 (6.2–50.0)	7.7 (3.4–12.5)	99.1 (16.7–100.0)
Surgeons caring for children with abdominal trauma	7 (5–10)	8 (6–10)	7 (4–10)

Continuous variables presented as median (interquartile range). Categorical variables presented as number (percent).
Total missing variables: surgeon type, 2; years in practice, 4; abdominal cases per year, 22; proportion of cases performed laparoscopically, 22; proportion of cases performed for trauma, 22; adult trauma level designation, 2; pediatric trauma level designation, 1; hospital type, 6; proportion of admitted patients pediatric, 77; surgeons caring for children with abdominal trauma 33.

Table 2
Surgeons management of four pediatric abdominal injury scenarios.

	All n = 394	Trauma surgeon n = 194	Pediatric surgeon n = 198
Isolated intra-abdominal injury			
Admit for observation	267 (67.8)	111 (57.2)	156 (78.8)
OR after observation			
Diagnostic laparoscopy	180 (68.2)	51 (47.2)	129 (82.7)
Exploratory laparotomy	84 (31.8)	57 (52.8)	27 (17.3)
Diagnostic laparoscopy	104 (26.4)	66 (34.0)	36 (18.2)
Exploratory laparotomy	23 (5.8)	17 (8.8)	6 (3.0)
Severe multisystem injury			
Admit for observation	198 (50.6)	71 (37.0)	127 (64.5)
OR after observation			
Diagnostic laparoscopy	118 (60.2)	22 (31.9)	96 (75.6)
Exploratory laparotomy	78 (39.8)	47 (68.1)	31 (24.4)
Diagnostic laparoscopy	139 (35.5)	77 (40.1)	61 (31.0)
Exploratory laparotomy	54 (13.8)	44 (22.9)	9 (4.6)
Traumatic brain injury with intubation			
Admit for observation	155 (39.3)	50 (25.8)	105 (53.0)
OR after observation			
Diagnostic laparoscopy	84 (54.9)	14 (28.6)	70 (67.3)
Exploratory laparotomy	69 (45.1)	35 (71.4)	34 (32.7)
Diagnostic laparoscopy	160 (40.6)	81 (41.8)	78 (39.4)
Exploratory laparotomy	79 (20.1)	63 (32.5)	15 (7.6)
Penetrating abdominal injury			
Admit for observation	154 (39.1)	80 (41.2)	73 (36.9)
Diagnostic laparoscopy	124 (31.5)	50 (25.8)	74 (37.4)
Bedside local wound exploration	57 (14.5)	35 (18.0)	21 (10.6)
OR for local wound exploration	59 (15.0)	29 (15.0)	30 (15.2)

Abbreviations: OR, operating room.

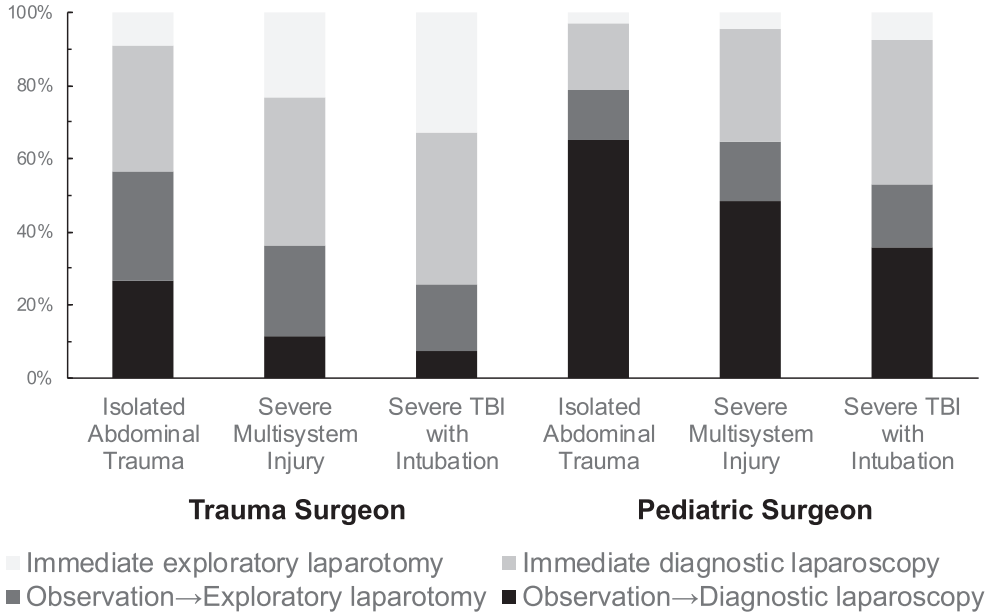

Fig. 1. Choice of surgeons in management of children with blunt abdominal injury. In each case, proportions are shown from top to bottom as: immediate exploratory laparotomy, immediate diagnostic laparoscopy, observation followed by exploratory laparotomy, and observation followed by diagnostic laparoscopy.

only complete the survey once.

1.3. Ethical considerations and approvals

After clicking on the survey link, participants read an informed consent statement and provided consent prior to completion of the survey. No identifying information was collected about the survey participants. The study was reviewed by the University of Washington Human Subjects Division and determined to be exempt from institutional review board review. The survey and use of the EAST and APSA web mail systems to solicit member participation was approved by the EAST Research-Scholarship Committee and the APSA Outcomes and Evidence Based Practice Committee.

1.4. Analysis

We used descriptive statistics to characterize surgeon and facility characteristics and to describe surgeon responses to each scenario. Multivariable logistic regression was used to determine factors associated with initial management choice of observation vs. operation, and if operative, laparoscopy vs. laparotomy for blunt injury and observation vs. local wound exploration vs. laparoscopy for penetrating injury. For the blunt injury model, injury type (isolated, multisystem, or TBI with intubation) was included as a factor variable and clustering by participant was accounted for. Factors included in the blunt injury model were injury type, surgeon type (trauma vs. pediatric), years in practice, and highest facility trauma level (I, II, III/IV, None). Factors included in the penetrating injury model were surgeon type (trauma vs. pediatric), years in practice, and facility trauma level (I, II, III/IV, None). Covariates were chosen based on a directed acyclic graph describing the relationship between surgeon and facility factors and management choice (Appendix B). We used complete case analysis because missingness of covariates was less than 2%. STATA/SE version 14 was used for all data analysis (StataCorp LP, College Station, TX).

2. Results

2.1. Survey response

An invitation email was sent to 1854 EAST members and 866 APSA members, of whom 384 (21.1%) and 216 (24.9%) surgeons responded, respectfully. Of the 600 respondents, 471 were eligible to participate in the study (did not provide consent [n = 5], did not care for children [n = 121], current trainee [n = 3]). An additional 77 participants who

Table 3
Multivariable regression analysis of factors associated with surgeon management of pediatric blunt abdominal trauma.

	Operation vs. observation	Immediate laparotomy vs. laparoscopy	Delayed laparotomy vs. laparoscopy
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Injury type			
Isolated	Reference	Reference	Reference
With multisystem injury	2.20 (1.78–2.72)	1.81 (1.20–2.74)	1.80 (1.40–2.31)
With traumatic brain injury	3.60 (2.79–4.66)	2.40 (1.50–3.82)	2.53 (1.75–3.65)
Surgeon type			
Trauma	Reference	Reference	Reference
Pediatric	0.32 (0.22–0.44)	0.28 (0.16–0.52)	0.15 (0.08–0.26)
Years in practice	1.02 (1.00–1.03)	1.00 (0.98–1.03)	1.05 (1.02–1.08)
Facility trauma level			
Level I	Reference	Reference	Reference
Level II	0.99 (0.64–1.55)	0.78 (0.42–1.43)	1.04 (0.53–2.06)
Level III-IV	0.60 (0.19–1.89)	0.76 (0.14–4.19)	4.36 (0.96–19.74)
None	0.49 (0.18–1.31)	4.44 (0.26–75.65)	1.39 (0.14–13.42)

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

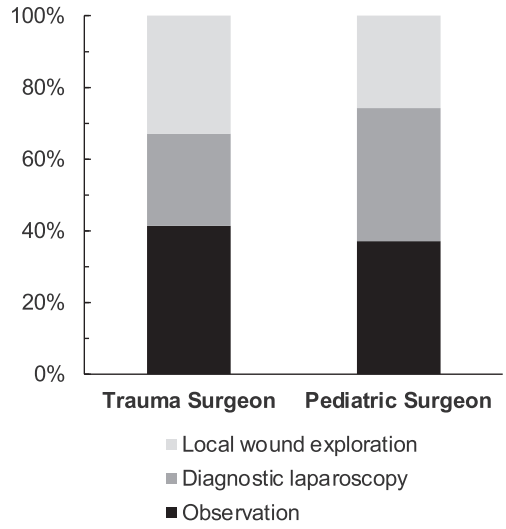

Fig. 2. Choice of surgeons in management of a child with penetrating abdominal injury.

did not complete the survey were excluded, giving a total of 394 participants included in the analysis.

2.2. Surgeon demographics

Of the 394 participants, 194 (49.2%) were trauma surgeons and 198 (50.3%) were pediatric surgeons (2 participants did not report surgeon type) (Table 1). Pediatric surgeons had been in practice longer than trauma surgeons with a median of 15 years (interquartile range [IQR]: 8–23) vs. 10 years (IQR: 4–20), respectively. A higher proportion of cases were performed laparoscopically for pediatric surgeons compared to trauma surgeons (66.6% vs. 50.0%). Trauma surgeons performed a higher proportion of trauma cases than pediatric surgeons (26.6% vs. 2.7%). A majority of facilities where both trauma and pediatric surgeons worked were adult level I trauma centers (74.2% and 60.7%); while, facilities where pediatric surgeons worked were more frequently also pediatric level I trauma centers (66.5% vs. 26.3%). Nearly half (44.9%) of trauma surgeons practiced at a facility with no pediatric trauma level designation.

2.3. Blunt injury management

For the isolated blunt injury scenario, most surgeons (67.8%) chose observation (Table 2). For the scenario with concomitant severe multisystem injury, fewer surgeons (50.6%) chose observation, and 35.5% chose diagnostic laparoscopy. For the scenario with severe TBI and intubation, only 39.3% chose observation, 40.6% chose diagnostic laparoscopy, and 20.1% chose exploratory laparotomy. For the surgeons who chose observation in each scenario, after the scenario progressed to the patient developing peritonitis 12 h later, the majority of surgeons chose diagnostic laparoscopy over exploratory laparotomy.

Surgeons were more likely to choose an operation for the scenarios with multisystem injury (aOR 2.20, 95% CI: 1.78–2.72) or TBI (aOR 3.60, 95% CI: 2.79–4.66) compared to the isolated injury scenario. Pediatric surgeons were less likely to choose an operation compared to trauma surgeons independent of the scenario (aOR 0.32, 95% CI: 0.22–0.44), and if they chose an operation, they more frequently chose diagnostic laparoscopy over exploratory laparotomy (OR 0.28, 95% CI: 0.16–0.52) (Fig. 1 and Table 3). Of those who chose initial observation, surgeons who had been in practice longer were more likely to choose laparotomy over laparoscopy after the patient developed peritonitis (aOR 1.05, 95% CI: 1.02–1.08). Facility trauma level was not independently associated with management choice.

2.4. Penetrating injury management

For the penetrating injury scenario, 39.1% of surgeons chose observation, 31.5% chose diagnostic laparoscopy, 29.5% chose local wound exploration, and 0% chose exploratory laparotomy (Table 2). Compared to trauma surgeons, pediatric surgeons were more likely to choose laparoscopy over observation (aOR 1.76, 95% CI: 1.07–2.90) and laparoscopy over local wound exploration (aOR 2.13, 95% CI: 1.25–3.62) (Fig. 2 and Table 4). Surgeons who had been in practice longer were less likely to choose local wound exploration over laparoscopy (aOR 0.97, 95% CI: 0.94–0.99). There was no association of facility trauma level with management choice.

2.5. Reasons for surgeon choice

For all scenarios combined, of surgeons who chose laparoscopic management, the most frequently cited reasons were that the surgeons always performed diagnostic laparoscopy in hemodynamically stable trauma patients with suspected abdominal injury (53%), that laparoscopy results in better outcomes than laparotomy (e.g. shorter hospital stay, lower rate of complications) (50%), and that surgeons wanted to avoid creating a large scar in their patients (43%) (Fig. 3A). Compared to pediatric surgeons, trauma surgeons more frequently cited better outcomes with laparoscopy (56% vs. 46%) and the desire to avoid risk of bowel obstructions and hernias in their patients (35% vs. 26%). Pediatric surgeons more frequently cited avoidance of a large scar (48% vs. 35%), parent preference (25% vs. 20%), better visualization (17% vs. 5%), and faster operation (15% vs. 5%) than trauma surgeons.

Of surgeons who chose laparotomy, 64% cited anticipating needing to perform a therapeutic intervention that they only performed open as a reason for choosing laparotomy. Other common reasons for choosing laparotomy were better visualization (47%) and feeling more com-

Table 4
Multivariable regression analysis of factors associated with surgeon management of pediatric penetrating abdominal trauma.

	Local wound exploration vs. observation	Laparoscopy vs. observation	Laparoscopy vs. local wound exploration
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Surgeon type			
Trauma	Reference	Reference	Reference
Pediatric	0.83 (0.50–1.37)	1.76 (1.07–2.90)	2.13 (1.25–3.63)
Years in practice	1.02 (0.99–1.05)	0.99 (0.96–1.01)	0.97 (0.94–0.99)
Facility Trauma Level			
Level I	Reference	Reference	Reference
Level II	0.79 (0.41–1.52)	1.06 (0.57–1.99)	1.35 (0.67–2.71)
Level III-IV	1.48 (0.38–5.72)	0.62 (0.11–3.52)	0.42 (0.08–2.30)
None	[a]	0.49 (0.04–5.53)	[a]

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.
[a] No observations of local wound exploration so the OR cannot be calculated.

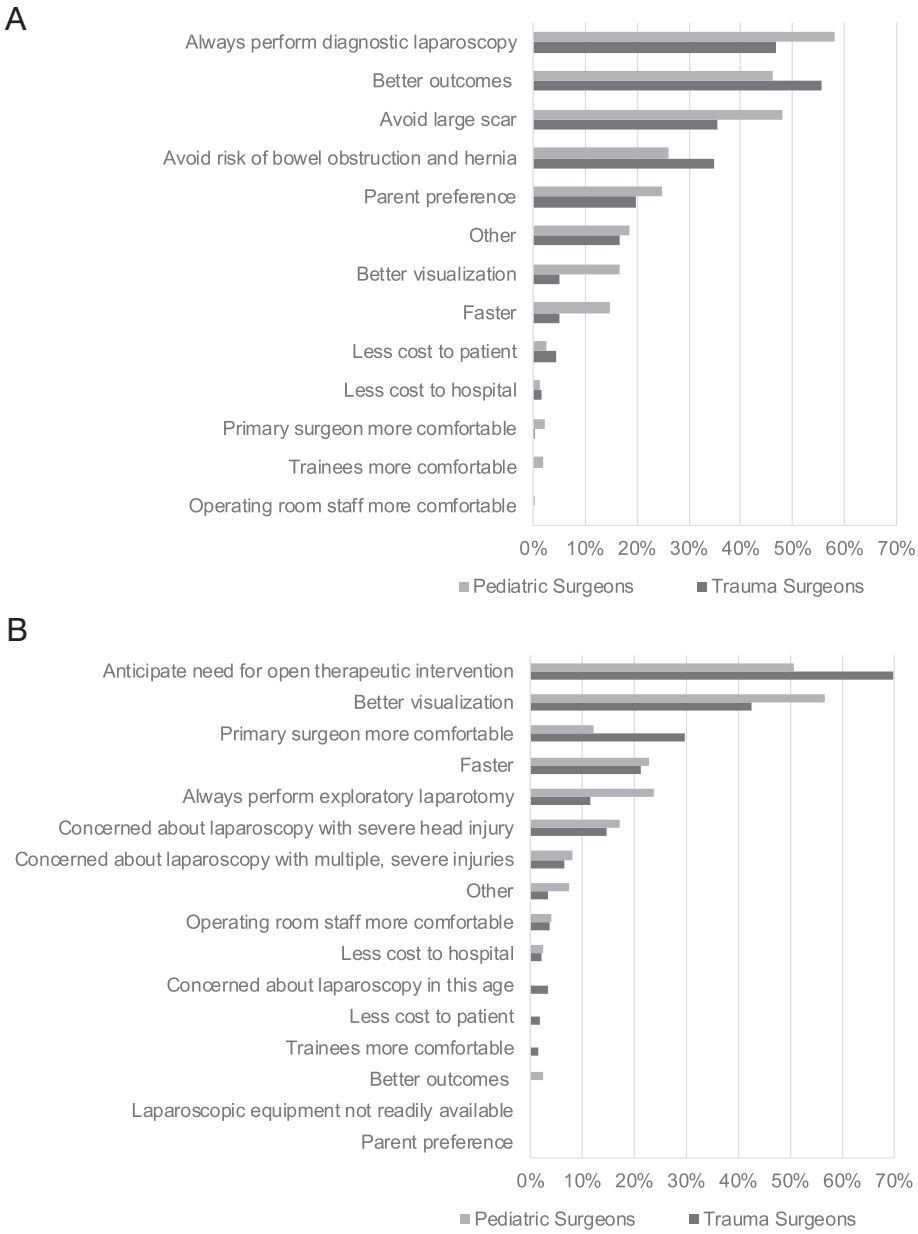

Fig. 3. Reasons for choice of (A) laparoscopy or (B) laparotomy in management of children with abdominal trauma.

fortable performing laparotomy over laparoscopy (24%) (Fig. 3B). Compared to pediatric surgeons, trauma surgeons more frequently cited anticipated need for an open therapeutic intervention (70% vs. 51%) and feeling more comfortable with laparotomy (30% vs. 12%). Pediatric surgeons more frequently cited better visualization than trauma surgeons (57% vs. 42%).

Very few surgeons listed cost to the patient or the hospital as a reason for choosing laparoscopy or laparotomy. No surgeons who chose laparotomy were concerned about lack of proper laparoscopy equipment at their hospital.

2.6. Reasons for conversion to laparotomy

When asked to select all reasons for converting from laparoscopy to laparotomy, the most frequently cited reasons were the primary surgeon felt uncomfortable with a laparoscopic repair (94%), need for liver resection (86%), need for nephrectomy (84%), patient hypotension (70%), and difficulty ventilating the patient (79%). For bowel injury, 72% of surgeons said they would convert to laparotomy for bowel resection and primary anastomosis, 67% for bowel resection and ostomy, and 46% for primary repair. Of all surgeons, 39% said they would convert to an open operation for any therapeutic intervention. In general trauma surgeons, more frequently selected all reasons for converting to laparotomy compared to pediatric surgeons (Fig. 4).

3. Discussion

In this study of surgeons caring for children with abdominal injury, we found no consensus on appropriate management for scenarios of blunt and penetrating injury. In fact, for the penetrating injury scenario, surgeons were nearly evenly split in their choice of management between observation, diagnostic laparoscopy, and local wound exploration. While there was greater consensus for the patient with an isolated blunt abdominal injury (68% chose observation), many surgeons still chose diagnostic laparoscopy (26%) or exploratory laparotomy (6%).

Concomitant injuries played a large role in surgeons' choices for management of blunt abdominal trauma. Surgeons were more likely

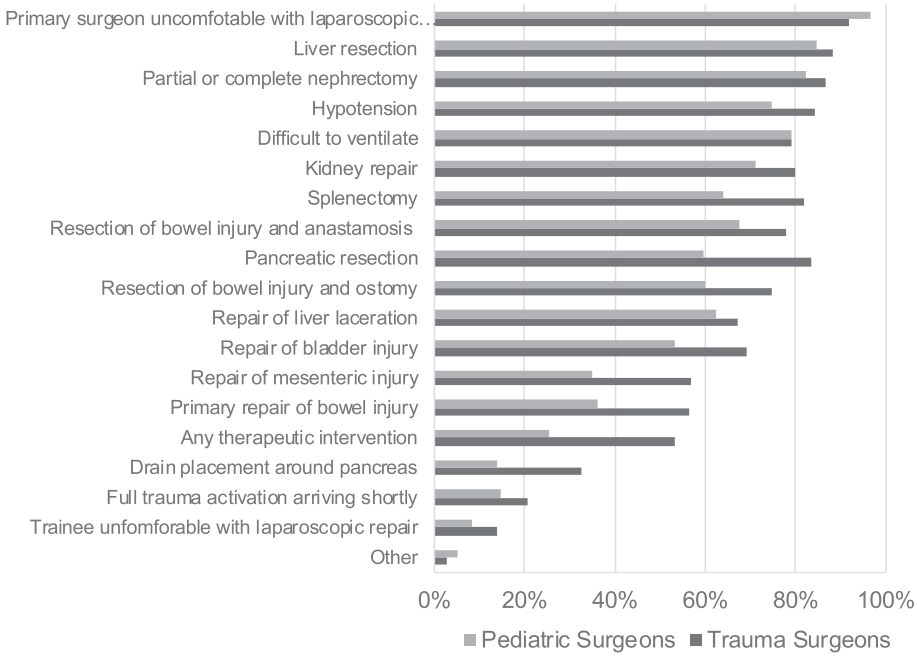

Fig. 4. Reasons for conversion to laparotomy in a child with blunt abdominal trauma.

to choose an operation if the child had severe multisystem injuries or a severe TBI with intubation compared to the child with an isolated abdominal injury. Children with multiple injuries may have a less reliable exam due to distracting injuries and may require multiple operations for repair of other injuries, limiting the ability to perform serial abdominal exams. In intubated patients, the clinician is not able to elicit a history or assess abdominal tenderness. These factors led many surgeons to choose an operative intervention; however, 51% and 39% of surgeons still chose non-operative management for multisystem injury and TBI, respectively.

Independent of patient injury type, pediatric surgeons consistently chose observation more frequently than trauma surgeons, and if they did choose operation, they more frequently chose laparoscopy over laparotomy. Several older studies found that pediatric trauma centers had higher rates of non-operative management for solid organ injury than adult trauma centers or non-trauma centers; however, since the implementation of evidence-based guidelines for management of solid organ injury, these differences have become less apparent [20,21]. The observed differences in management of potential hollow viscus injury are likely due to differences in training and general practice patterns in the setting of no evidence-based practice guidelines.

Of those who chose an operative approach, pediatric surgeons were more likely to choose laparoscopy than trauma surgeons. Pediatric surgeons more frequently cited parent preference and wanting to avoid a large scar as reasons for laparoscopy. Pediatric surgeons may be more attuned to children-specific factors such as parent preference and psychological impact of a large scar on a child. Additionally, trauma surgeons more frequently cited anticipating the need to perform a therapeutic procedure that they only perform via laparotomy as a reason for choosing laparotomy. They also more frequently chose each reason for converting to an open operation. Because pediatric surgeons perform a higher proportion of their cases laparoscopically, they may feel more comfortable applying laparoscopy to pediatric blunt abdominal trauma. Only 3% of trauma surgeons cited patient age as a reason for choosing laparotomy over laparoscopy, so age is less likely to play a role in surgeon choice.

Without evidence-based practice guidelines, surgeons must make clinical decisions based on their potentially limited experience and training in caring for children with suspected hollow viscus injuries. Because the incidence of bowel injury in abdominal trauma is low [2], many surgeons, particularly at non-trauma centers, may have never cared for a child with a potential hollow viscus injury. Although there is not definitive evidence on optimal management of children with potential hollow viscus injury, many children can be safely observed [13], and several studies in adults have advocated for watchful waiting rather than immediate operative intervention [5–8]. If operation is deemed necessary, laparoscopy can decrease negative laparotomies, avoid a large scar, decrease hospital length of stay, decrease risk of surgical site infection, and reduce the risk of bowel obstruction and incisional hernia [12,14,17–19].

This study has several limitations. This was a convenience sample of members of APSA and EAST, which is not representative of all surgeons caring for children with abdominal trauma. The majority of respondents worked at an academic medical center with a level I or II adult and/or pediatric trauma designation. However, nearly half of all injured children are cared for in non-trauma centers [24]. We anticipate that there is even wider variation in care of children at non-trauma centers, than that observed in our study. Due to the need to limit the length of the questionnaire, we were not able to address other factors that may affect surgeon choice including, younger patient age, patient sex, presence of solid organ injury, or specific CT findings other than free fluid. The questionnaire format also did not allow for surgeons to present nuances in patient factors that may influence their decisions. Finally, we have a relatively low response rate and many who responded were either ineligible or did not complete the survey. Non-responders may be inherently different than respondents, biasing our results.

In conclusion, we found significant variation in surgeon choice in management of children with abdominal trauma, depending on patient injury type and severity and surgeon type. Evidence-based guidelines are necessary to guide surgeon management in this group of patients.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpedsurg.2020.09.023.

References

[1] Lynch T, Kilgar J, al Shibli A. Pediatric Abdominal Trauma Current Pediatric Reviews, 14; 2018; 59–63. https://doi.org/10.2174/1573396313666170815100547.

[2] Bège T, Brunet C, Berdah SV. Hollow viscus injury due to blunt trauma: a review. J Visc Surg. 2016;153:61–8. https://doi.org/10.1016/j.jviscsurg.2016.04.007.

[3] Ng AKT, Simons RK, Torreggiani WC, et al. Intra-abdominal free fluid without solid organ injury in blunt abdominal trauma; an indication for laparotomy. Journal of Trauma. 2002;52:1134–40. https://doi.org/10.1097/00005373-200206000-00019.

[4] Gonser-Hafertepen LN, Davis JW, Bilello JF, et al. Isolated free fluid on abdominal computed tomography in blunt trauma: watch and wait or operate? J Am Coll Surg. 2014;219:599–605. https://doi.org/10.1016/j.jamcollsurg.2014.04.020.

[5] Oyo-Ita A, Chinnock P, Ikpeme IA. Surgical versus non-surgical management of abdominal injury. Cochrane Database Syst Rev. 2015;2015:CD007383. https://doi.org/10.1002/14651858.CD007383.pub3.

[6] Goedecke M, Kühn F, Stratos I, et al. No need for surgery? Patterns and outcomes of blunt abdominal trauma. Innovative Surgical Sciences. 2020;4:100–7. https://doi.org/10.1515/iss-2018-0004.

[7] Livingston DH, Lavery RF, Passannante MR, et al. Free fluid on abdominal computed tomography without solid organ injury after blunt abdominal injury does not mandate celiotomy. Am J Surg. 2001;182:6–9. https://doi.org/10.1016/s0002-9610(01)00665-1.

[8] Bekker W, Smith MTD, Kong VY, et al. Isolated free fluid on computed tomography for blunt abdominal trauma – a South African experience. Ann R Coll Surg Engl. 2019;101:552–7. https://doi.org/10.1308/rcsann.2019.0078.

[9] Malinoski DJ, Patel MS, Yakar DO, et al. A diagnostic delay of 5 hours increases the risk of death after blunt hollow Viscus injury. The Journal of Trauma: Injury, Infection, and Critical Care. 2010;69:84–7. https://doi.org/10.1097/TA.0b013e3181db37f5.

[10] Fakhry SM, Brownstein M, Watts DD, et al. Relatively short diagnostic delays (<8 hours) produce morbidity and mortality in blunt small bowel injury: an analysis of time to operative intervention in 198 patients from a multicenter experience. Journal of Trauma - Injury, Infection and Critical Care. 2000;48:408–15. https://doi.org/10.1097/00005373-200003000-00007.

[11] Jerby BL, Attorri RJ, Morton D. Blunt intestinal injury in children: the role of the physical examination. J Pediatr Surg. 1997;32:580–4. https://doi.org/10.1016/S0022-3468(97)90711-9.

[12] Pearson EG, Clifton MS. The role of minimally invasive surgery in pediatric trauma. Surg Clin North Am. 2017;97:75–84. https://doi.org/10.1016/j.suc.2016.08.005.

[13] Arbra CA, Vogel AM, Zhang J, et al. Acute procedural interventions after pediatric blunt abdominal trauma: a prospective multicenter evaluation. Journal of Trauma and Acute Care Surgery. 2017;83:597–602. https://doi.org/10.1097/TA.0000000000001533 Lippincott Williams and Wilkins.

[14] Lee PC, Lo C, Wu JM, et al. Laparoscopy decreases the laparotomy rate in hemodynamically stable patients with blunt abdominal trauma. Surg Innov. 2014;21:155–65. https://doi.org/10.1177/1553350612474496.

[15] Cherkasov M, Sitnikov V, Sarkisyan B, et al. Laparoscopy versus laparotomy in management of abdominal trauma. Surg Endosc. 2008;22:228–31. https://doi.org/10.1007/s00464-007-9550-z.

[16] Justin V, Fingerhut A, Uranues S. Laparoscopy in blunt abdominal trauma: for whom? When? And why? Current Trauma Reports. 2017;3:43–50. https://doi.org/10.1007/s40719-017-0076-0.

[17] Li Y, Xiang Y, Wu N, et al. A comparison of laparoscopy and laparotomy for the management of abdominal trauma: a systematic review and meta-analysis. World J Surg. 2015;39:2862–71. https://doi.org/10.1007/s00268-015-3212-4.

[18] Gaines BA, Rutkoski JD. The role of laparoscopy in pediatric trauma. Semin Pediatr Surg. 2010;19:300–3. https://doi.org/10.1053/j.sempedsurg.2010.08.001.

[19] Butler EK, Mills BM, Arbabi S, et al. Laparoscopy compared with laparotomy for the management of pediatric blunt abdominal trauma. Journal of Surgical Research. 2020;251:303–10. https://doi.org/10.1016/j.jss.2020.01.030.

[20] Stylianos S, Ford HR. Outcomes in pediatric trauma care. Semin Pediatr Surg. 2008;17:110–5. https://doi.org/10.1053/j.sempedsurg.2008.02.006.

[21] Shimizu T, Umemura T, Fujiwara N, et al. Review of pediatric abdominal trauma: operative and non-operative treatment in combined adult and pediatric trauma center. Acute Medicine & Surgery. 2019;6:358–64. https://doi.org/10.1002/ams2.421.

[24] Segui-Gomez M, Chang DC, Paidas CN, et al. Pediatric trauma care: an overview of pediatric trauma systems and their practices in 18 US states. J Pediatr Surg. 2003;38:1162–9. https://doi.org/10.1016/S0022-3468(03)00262-8.