
Variation in Treatment of Pediatric Spleen Injury at Trauma Centers Versus Nontrauma Centers: A Call for Dissemination of American Pediatric Surgical Association Benchmarks and Guidelines

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- BACKGROUND:** American Pediatric Surgical Association consensus guidelines for children with blunt spleen injuries have been defined and validated in children's hospitals, but large administrative data sets indicate that only 10% to 15% of children with blunt spleen injuries are treated at children's hospitals. We sought to identify the frequency and compare the treatment of children with spleen injury in hospitals with and without recognized trauma expertise, with the aim of identifying a meaningful target for dissemination of benchmarks and consensus guidelines.
- STUDY DESIGN:** State health departments' administrative data sets from California, Florida, New Jersey, and New York were analyzed for 2000, 2001, and 2002. All children with head injury or other nonspleen abdominal injuries requiring surgery were excluded. Injury Severity Scores were determined by ICDMAP-90.
- RESULTS:** There were 3,232 patients with blunt spleen injury. Trauma centers had a significantly lower rate of operation for both multiply injured patients (15.3% versus 19.3%, $p < 0.001$) and those with isolated injury (9.2% versus 18.5%, $p < 0.0001$) when compared with nontrauma centers. The operative rates at both trauma centers and nontrauma centers exceed published American Pediatric Surgical Association benchmarks for all children with spleen injury (5% to 11%) and the subset with isolated spleen injury (0% to 3%). Independent risk factors for splenectomy included ages 15 to 19 years ($p < 0.002$), spleen injury severity ($p < 0.0001$), and presence of multiple injuries ($p < 0.04$). Adjusted odds ratio for risk of splenic operation in all patients with spleen injury was 2.122 (95% CI:1.455– 3.096) when treated at a nontrauma center ($p < 0.0001$).
- CONCLUSIONS:** These multistate discharge data indicate that treatment of children with blunt spleen injury differs significantly when comparing trauma centers and nontrauma centers. Because nearly two-thirds of these children were treated at trauma centers, dissemination of American Pediatric Surgical Association guidelines and benchmarks through state or regional trauma systems may reduce the number of children having operations for splenic injury. (J Am Coll Surg 2006;202: 247–251. © 2006 by the American College of Surgeons)
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Significant variation in clinical practice patterns has attracted the attention of specialty organizations, payors, government health agencies, and the public. Es-

tablishment of national benchmarks is an increasing priority.¹ Treatment of pediatric spleen injury, although not a high-profile public health issue, is a

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Table 1. Distribution of Blunt Spleen Injury Patients

Variables	Trauma center (%)	Nontrauma center (%)	p Value
Multiple injuries (n = 1,299)	15.3	19.3	< 0.001
Isolated spleen injuries (n = 1,933)	9.2	18.5	< 0.0001
Total (n = 3,232)	12.1	18.8	< 0.0001

relevant example of significant practice variation in pediatric trauma care.

The majority of children with spleen injury follow a predictable course, yet the rate of operative treatment varies widely depending on the expertise of the treating physician and institution. Historically, there have been higher rates of operation and splenectomy in children treated at general hospitals than in those treated at pediatric trauma centers and adult trauma centers with strong pediatric commitment.²⁻⁶

The American Pediatric Surgical Association (APSA) Committee on Trauma recently defined and disseminated guidelines for resource use and benchmarks for nonoperative treatment in children with isolated blunt spleen injury.^{7,8} Other recent studies have established rate of operation benchmarks in children with spleen and associated injuries.⁹⁻¹³ Because most children with spleen injury are not admitted to pediatric hospitals, it is imperative that there be effective dissemination of APSA benchmarks.

We sought to compare the rate of nonoperative treatment between hospitals with and without recognized trauma expertise, using a large database of children with blunt spleen injury. This analysis may identify targets for further dissemination of APSA guidelines and benchmarks.

METHODS

State uniform hospital discharge data sets from California, Florida, New Jersey, and New York were used to determine variations in the treatment of children with blunt spleen injury from 2000 to 2002. The four state agencies that provided these data were: California's Office of Statewide Health Planning and Development; the Florida Department of Health, Florida Discharges Data Abstracts; New Jersey's Department of Health and Senior Service UB92; and New York State Health Department's, Statewide Planning and Research Cooperative System (SPARCS). These data sets, representing 30 million discharges, followed the Uniform Hospital Minimum Discharge Data Survey's recommended variable elements. International Classification of Diseases 9th Edition (ICD-9) diagnosis codes 865.0 to 865.99 were the primary search criteria. Discharge abstracts included demographic and clinical variables. Typical variables included, but were not limited to, age, gender, race, hospital identification, principal payor, principal diagnoses and multiple secondary diagnoses (ICD-9-CM), principal procedure and multiple procedures codes (ICD-9-CM), length of stay, and outcomes. Pediatric spleen injury populations were defined as patients 18 years old and younger. Independent risk factors for operation were identified and the adjusted risk determined. Injury Severity Scores were calculated using ICDMAP-90 software (Tri-Analytics, Inc). Trauma center designation was determined using a combination of three sources, including the American Hospital Association's (AHA) guide book, direct telephone interviews, and Internet Web sites.

Variables were analyzed using the *t*-test for continuous variables and the chi-square test for dichotomous

Table 2. Pediatric Surgery Benchmarks for Operative Rate in Children with Spleen Injury

First author	Database	Study period	n	Operative rate pediatric surgeon and/or children's hospital-PTC, %	Spleen injuries
Mooney ¹⁰	KID 2000-AHRQ	2000	322	5	All
Davis ¹²	Pennsylvania Trauma Outcome Study-UHDDS	1991–2000	507	5	All
Mooney ¹¹	New England Pediatric Trauma Database-UHDDS	1990–1998	866	11	All
Stylianou ^{7,8}	APSA Trauma Committee-Multicenter registry	1995–2000	652	3	Isolated
Mooney ⁹	Children's Hospital-Boston Trauma registry	1993–1999	82	0	Isolated

APSA, American Pediatric Surgical Association; Kid 2000-AHRQ, Agency for Healthcare Research and Quality's Hospital Cost Utilization Project State Inpatient Database for the Year 2000; PTC, Pediatric Trauma Center; UHDDS, Uniform Hospital Discharge Data Sets.

Table 3. Risk Factors Associated with Significant Increased Probability of Operation for Spleen Injury

Independent risk factors	Odds ratio (95% CI)	p Value
Age 15–19 y	4.19 (1.95–8.98)	< 0.0002
Spleen injury severity		
ICD-9 code: 865.02 Tears	1.55 (1.01–2.37)	< 0.044
ICD-9 code: 865.03 Laceration	3.44 (2.35–5.04)	< 0.0001
ICD-9 code: 865.04 Massive	10.62 (6.99–16.11)	< 0.0001
Multiple injuries	1.38 (1.01–1.90)	< 0.046

variables. A multivariate logistic regression model was used to examine the relation between splenectomy and trauma center status of the treating institutions, controlling for age, gender, and Injury Severity Score of the patients. All data were analyzed using SAS Version 9.1 (SAS Institute).

RESULTS

The four-state database identified 3,232 patients with blunt spleen injury, including 1,933 patients with isolated spleen injury. Nearly two-thirds (65.8%) of the patients were treated at trauma centers. Trauma centers had a significantly lower rate of operation for both multiply injured patients (15.3% versus 19.3%, $p < 0.001$) and those with isolated injury (9.2% versus 18.5%, $p < 0.0001$) when compared with nontrauma centers (Table 1). The operative rates at both trauma centers and nontrauma centers exceed published APSA benchmarks (Table 2) for all children with spleen injury (5% to 11%) and those with isolated spleen injury (0% to 3%).

Independent risk factors for splenectomy are depicted in Table 3. Adjusted odds ratio for risk of splenic operation in all patients with spleen injury was 2.122 (95% CI: 1.455–3.096) when treated at a nontrauma center ($p < 0.0001$).

The 1,933 children with isolated spleen injury are summarized in Table 4, which includes the ICD-9 codes for blunt splenic injury severity. A significantly increased

rate of operation was found at nontrauma centers when individual severity levels were compared.

DISCUSSION

Optimal care of pediatric trauma patients requires that the responsible trauma surgeon and treating institution have specific expertise and resources. Several authors have reported similar survival statistics for injured children treated by adult trauma surgeons, usually in adult centers.^{4,14,15} In contrast, comparison of treatment in children with spleen injury from four studies demonstrated a significantly higher rate of operation (46% versus 17%, $p < 0.001$) by adult surgeons versus pediatric surgeons.^{2,3,5,16} These data represent comparison of crude operative rates in small select cohorts and are not adjusted for independent risk variables. Recent studies of large databases, including nearly 6,000 children with spleen injury, indicate that the rate of operation has decreased for both pediatric and adult trauma surgeons, but a significant difference (30% versus 9%, $p < 0.0001$) persists.^{11,12} Reports of adult trauma surgeons approaching pediatric surgery benchmark rates of operation are sparse.^{16,17} Because the appropriate nonoperative treatment of children with blunt spleen injury has been found to reduce the need for and risks of transfusion and decrease length of hospital stay compared with that for operative intervention, this variation in treatment is troubling.¹⁸

Analysis of variation in treatment requires adjustment for independent risk factors. The severity of the spleen injury is a consistently significant risk factor for operative treatment in this and other studies.^{10-12,19} The impact of trauma surgeon training and institutional resources on the operative rate in children with spleen injury from four recent studies is shown in Table 5.¹⁰⁻¹² The adjusted odds ratio for splenectomy is significantly higher in each comparison, indicating ineffective dissemination or implementation of current knowledge. In

Table 4. Comparison of Treatment in Patients with Isolated Spleen Injury

Variables	Trauma center (n = 1,083)	Nontrauma center (n = 850)	p Value
Mean Injury Severity Score	8.5	9.2	NS
Rate of operative treatment, %	9.23	18.47	< 0.0001
ICD-9 code: 865.01 Hematoma	3.45	3.92	NS
ICD-9 code: 865.02 Tears	4.76	12.39	< 0.02
ICD-9 code: 865.03 Laceration	12.17	26.58	< 0.004
ICD-9 code: 865.04 Massive	33.33	46.67	< 0.02

Table 5. Effect of Hospital Type and Professional Training on the Probability of Splenic Operation

First author	Database	Comparison	n	Patient distribution, %	Adjusted odds ratio (95% CI)	p Value
Mooney ¹⁰	KID 2000-AHRQ	General hospital vs children's hospital	2,191	85:15	2.85 (1.43–5.69)	< 0.003
Mooney ¹¹	New England Pediatric Trauma Database-UHDDS	General surgeon vs pediatric surgeon	2,631	68:32	3.1 (2.3–4.4)	< 0.0001
Davis ¹²	Pennsylvania UHDDS	Adult or non-TC vs pediatric TC	3,145	85:15	6.19 (4.43–8.66)	< 0.0001
This study	CA, FL, NJ, NY UHDDS	Non-TC vs TC	3,232	34:66	2.12 (1.45–3.09)	< 0.0001

Kid 2000-AHRQ, Agency for Healthcare Research and Quality's Hospital Cost Utilization Project State Inpatient Database for the Year 2000; TC, trauma center; UHDDS, Uniform Hospital Discharge Data Sets.

addition, these studies emphasize that the majority of children with spleen injury are treated by adult surgeons in adult facilities. This indicates that guidelines and benchmarks, developed and tested at children's hospitals, must have wider dissemination and implementation to have maximal impact.

Mooney and Forbes¹¹ reported findings similar to those delineated here, that children treated at non-trauma centers had a significantly increased probability of having a splenectomy than those treated at trauma centers. It is important to note that the majority of patients in this study were treated at hospitals with trauma expertise, representing a logical group for focus. Presentation and publication of current benchmarks and guidelines at pediatric surgical meetings and journals may limit the benefit to children treated outside of children's hospitals. Given the obvious benefits of nonoperative treatment for children with blunt spleen injury, better strategies for more widespread dissemination and implementation of benchmarks and guidelines are needed.

Dissemination strategies should include presentation at meetings and publication in journals influencing adult trauma surgeons and general surgeons. Incorporation of benchmarks as part of a state or regional trauma system quality assurance/quality improvement process and as a site verification audit filter are also possible strategies. Funding would be required to create audiovisual educational tools that could be sent to state trauma leaders for distribution. Finally, reimbursement decisions will be influenced by performance when quantifiable evaluation, such as this study, is possible. All of these suggestions are intended to optimize care of injured children across all hospital types and by all trauma providers.

Author Contributions

Study conception and design: Stylianou, Guice, Oldham

Acquisition of data: Egorova, Arons

Analysis and interpretation of data: Stylianou, Egorova, Arons

Drafting of manuscript: Stylianou, Egorova, Guice, Arons, Oldham

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