MAJOR ABDOMINAL INJURIES IN CHILDREN
A COMPUTERIZED STUDY OF THE STATE OF CONNECTICUT

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Abdominal injuries in children constitute a major surgical problem in the United States, though they constitute less than five per cent of childhood injuries. Since trauma is the leading cause of death in children in the United States, any potentially lethal wound that accounts for a significant proportion of all injuries in those under 14 years of age poses a threat demanding serious attention; and the lethal potential of abdominal injuries needs no elaboration. It is the purpose of this paper to describe the characteristics of 57 children who suffered major abdominal injuries in the State of Connecticut during the year 1971.

METHOD OF STUDY

In 1971 the Connecticut Society of American Board Surgeons and the Yale Trauma Program, two organizations with intense interest in the problems of the injured, undertook a prospective, computerized study of major abdominal injuries.[1] Included in the study were all patients from 35 hospitals who either: 1) required laparotomy for abdominal injury, or 2) died of abdominal injuries prior to laparotomy. The hospitals involved included 99.4 per cent of Connecticut's general medical and surgical beds. The study period included the entire year of 1971. A total of 345 patients underwent investigation. Computerization of data was arranged.

Among the total of 345 patients were 57 under 15 years of age. These 57 children comprise the study group. Similarities and differences between these children and the total number of patients in the statewide investigation were noted.

RESULTS

Age and Sex. Ages ranged from two years to fourteen years. Thirty-six children (63.2 per cent) were five through nine years of age. Forty-four patients (77.2 per cent) were boys, and 13 (22.8 per cent) were girls.

Nature of Injuries. Fifty-four children (94.7 per cent) sustained blunt injuries. Table I lists the types of injuries suffered by these youngsters.

TABLE I - Mechanisms of Blunt Injuries

Mechanism	Number of Children
Automobile Passenger	14
Home Accidents	11
Falls	8
Struck by Automobile as Pedestrian	7
Bicycling Accidents	6
Sledding Accidents	6
Miscellaneous	2
Total	54

Automobiles were implicated in 21 (38.9 per cent) of these accidents. The most unusual blunt injury occurred when a child suffered a ruptured liver as a result of being struck in the back by a high-velocity model airplane.

The three children with penetrating wounds included two home accidents and one boy of fourteen who was assaulted.

None of these injured children was identified as a victim of child abuse.

The organs injured in the 57 children are listed in Table II.

TABLE II - Organ Injuries

Organ Injured	Number
Spleen	34
Liver	6
Kidney	5
Jejunoileum	5
Others*	6
Total	56

* One each of duodenum, pancreas, appendix, colon, mesentery, and diaphragm

Splenic rupture accounted for 34 (63.0 per cent) of all blunt injuries.

In the three penetrating injuries, one child had a mesenteric perforation, one had injuries of liver and kidney, and one had only evisceration of abdominal contents without further intra-abdominal injury being discovered at operation.

Single abdominal organ injuries were present in 47 children (82.4 per cent). In five (8.8 per cent), two organs within the abdomen were injured. In five children (8.8 per cent) no abdominal organ injuries were found.

State of Consciousness. Fourteen patients (24.6 per cent), all but one with blunt injuries, were admitted unconscious or with altered states of consciousness. The remainder were alert on admission.

Hemodynamic Status. Eighteen children (31.6 per cent) were admitted in shock. All of these children were victims of blunt injury.

Preoperative Diagnostic Studies. Table III lists studies performed prior to operation on these patients.

TABLE III - Preoperative Diagnostic Studies
(Studies in Patients with Perforating Wounds in Parentheses)

Studies	Number	Per Cent
Hemoglobin and/or Hematocrit	57 (3)	100.0
White Blood Count	56 (3)	98.2
Blood Type and Cross-Match	53 (3)	93.0
Urinalysis	44 (2)	77.2
Abdominal Roentgenogram	40 (2)	70.2
Chest Roentgenogram	39 (2)	68.4
Diagnostic Paracentesis Without Lavage	15 (1)	26.3
Catheterization of Bladder	10 (1)	17.5
Diagnostic Paracentesis With Lavage	9	15.8
Intravenous Urogram	9	15.8
Serum Electrolytes	7	12.3
Serum Amylase	6	10.5
Other Contrast Roentgenograms	2	3.5
Splenic Scan	1	1.8
Blood Gases	1	1.8
Other	4	7.0

Associated Injuries. Nineteen children with blunt abdominal trauma (35.2 per cent) suffered major, associated, non-abdominal wounds. One child with penetrating abdominal injury had a major additional laceration. The injuries associated with blunt abdominal trauma are listed in Table IV.

TABLE IV - Major Non-Abdominal Injuries in 54 Children With Blunt Abdominal Trauma

Injury	Number
Extremity Fractures	10
Lacerations	3
Thoracic Wall Injuries	3
Pelvic Fractures	3
Intracranial Injuries	2
Skull Fractures	2
Intrathoracic Injuries	1
Facial Bone Fractures	1

Indication for Operation. The primary indications for operation in the children under study are listed in Table V.

TABLE V - Primary Indication for Operation

Indication	Number	Per Cent
Peritoneal Symptoms and/or Signs	26	45.6
Positive Peritoneal Aspiration	17	29.8
Hemorrhage and/or Unexplained Hypovolemia	8	14.0
Contrast Roentgenogram	2	3.5
Plain Roentgenogram	1	1.8
Penetrating Abdominal Wound	1	1.8
Gunshot Wound	1	1.8
Evisceration	1	1.8

In the three children in whom radiographic studies provided the indication for operation, the specific abnormalities revealed were 1) ruptured diaphragm noted on plain films, 2) enlargement of the spleen indicated by upper gastrointestinal contrast study, and 3) renal injury shown by angiography.

Among the 17 children in whom positive peritoneal aspiration was the primary indication for operation, 11 had peritoneal aspiration without lavage and six had diagnostic peritoneal lavage. Peritoneal aspiration alone provided the primary indication for operation in 11 (73.3 per cent) of 15 children in whom it was performed; diagnostic peritoneal lavage provided the primary indication in 6 (66.7 per cent) of 9 instances in which it was employed. Peritoneal aspiration with or without lavage thus provided the primary indication for operation in 70.8 per cent of children having it performed. Shock was present in seven children (29.2 per cent) of those having peritoneal aspiration, and five of the seven had major non-abdominal injuries. Unconsciousness or altered consciousness was present in nine children (37.5 per cent) undergoing peritoneal aspiration, and positive peritoneal aspiration was the primary indication for operation in eight of them. Three children undergoing laparotomy because of peritoneal aspirates (two with lavage and

one without lavage) interpreted as positive were found to have no intra-abdominal injuries at operation; the "true positive" rate for peritoneal aspiration was therefore 14 (82.4 per cent) of 17 procedures.

Time Interval from Hospitalization to Operation. Forty-two children with blunt trauma (77.8 per cent) underwent operation within eight hours of admission. All three children with penetrating injuries reached the operating room within four hours of hospital admission.

Abdominal Operative Procedures. Splenectomy was performed in all 34 instances in which splenic injuries were encountered. Hepatorrhaphy was required in four liver injuries, and in one instance a liver laceration was packed with gauze; no definitive procedure was required in a liver wound resulting from gunshot injury. Two kidney injuries were repaired, and three needed no intervention at the time of operation. Four of five small-bowel injuries required resection; one was managed by mural repair. Duodenal repair was performed in the child with duodenal injury. The single diaphragmatic rupture was repaired. One mesenteric tear was sutured. A minor colonic injury required no definitive management. A tear of the appendiceal artery prompted appendectomy in one child. The single pancreatic injury was drained.

In five patients, all with blunt injuries, no intra-abdominal organ was found to be injured at operation. Thus, the rate of "negative" laparotomy for the entire group of children was 8.8 per cent. As noted above, peritoneal aspirations had been interpreted as positive in three of these five children.

Table VI shows the length of operation in 56 of the children. In one instance the length of operation was unknown.

TABLE VI - Length of Operation in 56 Children

Time Interval		Number of Patients
From	To	
0 min.	29 min.	None
30 min.	59 min.	9
60 min.	89 min.	21*
90 min.	119 min.	18*
2 hr. 0 min.	3 hr. 59 min.	8*

*One patient with penetrating abdominal injury.

Abdominal drainage of one type or another was utilized in 21 patients (36.8 per cent).

Complications. Postoperative complications occurred in ten children (18.5 per cent) with blunt abdominal trauma. None occurred in the three children with penetrating wounds. Table VII lists the postoperative complications encountered.

TABLE VII - Postoperative Complications Following Laparotomy for Blunt Abdominal Injury

Complication	Number of Patients
Pulmonary Atelectasis	5
Pneumonia	2
Ileus	2
Wound Abscess	1
Biliary Fistula	1
Urinary Tract Infection	1
Subphrenic Abscess	1
Intestinal Obstruction	1
Laryngeal Edema	1
Convulsions	1
Drug Allergy	1
Postoperative Pancreatitis	1
Total	18

Mortality. No deaths were reported in the children in this study.

Length of Hospitalization. Table VIII shows the number of hospital days involved in the treatment of these youngsters.

TABLE VIII - Length of Hospitalization

Hospital Days	Number of Children
0 - 5	7
6 - 10	25*
11 - 15	10
16 - 20	3
21 - 25	4
26 - 30	2
Over 30	5
Unknown	1

*Includes all three children with penetrating injuries

Thirty-two children (56.1 per cent) were discharged from the hospital ten days or less after admission. Forty-two children (73.7 per cent) required no more than 15 days' hospitalization.

Comparison Between All Patients and Children in Statewide Connecticut Study. Table IX compares data obtained from patients of all ages in the Connecticut study and those relating only to the 57 children described herein.

TABLE IX - Comparison Between Children and Patients of All Ages in Connecticut Study

Datum	Per Cent		P
	Children	All Ages	
Males:Females	77.2:22.8	76.7:23.3	N.S.*
Blunt Injury	94.7	66.6	<.001
Automobile Accidents	36.8	38.2	N.S.
Criminal Assaults	1.8	23.0	<.001
Splenic Injuries in Blunt Trauma	63.0	49.8	<.05
Liver Injuries in Blunt Trauma	9.3	21.8	<.05
No Disturbance of Consciousness	75.4	64.2	N.S.
Shock	31.6	44.0	<.05
Major Non-Abdominal Injuries	35.1	33.0	N.S.
Indication for Operation:			
Peritoneal Irritation	45.6	31.6	<.05
Positive Peritoneal Aspiration	29.8	22.8	N.S.
Hemorrhage and/or Hypovolemia	14.0	15.5	N.S.
<8 Hr. Interval, Hospital Admission to Operation	78.9	82.9	N.S.
Negative Laparotomy	8.8	8.7	N.S.
Postoperative Complications	17.5	41.8	<.001
Hospital Stay <15 Days	73.7	59.2	<.05
Mortality	0	13.6	<.01
Patients Admitted to Hospitals of 0-249 Beds	31.6	22.9	
Patients Admitted to Hospitals of 250-449 Beds	29.8	28.1	
Patients Admitted to Hospitals of >450 Beds	38.6	49.0	

*Not Significant

DISCUSSION

With the growth of pediatric surgery and the rejuvenated interest in trauma as a major public health menace, an increasingly sharp focus on childhood injuries can be discerned in recent surgical literature.

Abdominal injuries are important in children primarily because they are a source of substantial morbidity and of mortality to a lesser degree. In most studies, mortality has been largely a function of non-abdominal injuries.

This study seems noteworthy because it includes major childhood abdominal injuries occurring within a recent twelve month period and because it can be compared to a larger study of major abdominal injuries in all age

groups with the same population base and within the same time frame.

Similar to most series dealing with childhood abdominal injuries are the preponderance of males and of non-penetrating injuries found here.

There seems to be little need for calling complex investigative studies into play in children with abdominal injuries. The decision for laparotomy was made without even the use of radiologic study in 94.7 per cent of the children in this group.

The usefulness of peritoneal aspiration in the evaluation of abdominal injury is again confirmed. While this technique is principally of value in blunt trauma, occasional penetrating injuries may be encountered in which the existence of suspected or unsuspected intra-abdominal involvement may be evaluated. Since three of five children undergoing negative laparotomy in these children had false positive peritoneal aspiration as the primary indication for operation, the need for careful assessment of the results of aspiration is underscored. Most important in this regard is the quantitation of blood in the peritoneal cavity when diagnostic peritoneal lavage is employed, as stressed by Perry[2] and Olsen[3].

Despite recent questions regarding the necessity for splenectomy, when minor splenic injuries are encountered, it would seem prudent to await accurate and reliable criteria for approaches other than splenectomy in such instances. Resolution of the problem of late hemorrhage in splenic injuries has not yet been demonstrated even at a time when splenectomy remains the standard therapy for all splenic injuries.

The relatively low complication rate and the absence of mortality in these children, as compared to all patients in the Connecticut study, seems related to overall differences in the severity of injuries sustained. Although non-abdominal injury was similar in patients of all ages, children showed a lower incidence of shock and of unconsciousness. The high incidence of single-organ abdominal injuries in these children is also of obvious importance, since the direct relationship between mortality and number of abdominal organs injured is well known.

The significant differences noted between children and victims of all ages in incidence of splenic and liver injuries are fascinating. Possible reasons for such differences are not forthcoming from the data in this study but seem worthy of further investigation. The author is not aware that such differences have been previously reported.

CONCLUSION

Injuries to the abdomen do not constitute a large proportion of childhood injuries, and they should not, of themselves, cause very many deaths. They are nonetheless potentially lethal and require prompt and expert management if mortality and excessive morbidity are to be avoided. That this obviation can be realized is exemplified by this study.

REFERENCES

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