



Outcomes in pediatric patients with abdominal compartment syndrome following urgent exploratory laparotomy



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ABSTRACT

Background/purpose: Abdominal compartment syndrome (ACS) is a serious condition with high mortality in critically ill children. Our objectives were to characterize the incidence of ACS in pediatric patients who underwent urgent exploratory laparotomy and to compare outcomes of patients with and without ACS.

Methods: This retrospective review examined pediatric patients (0–18 years) who underwent urgent exploratory laparotomy over a 2-year period. Primary outcome was mortality; secondary outcomes were achievement of primary fascial closure and necessity of bowel resection.

Results: One hundred nineteen patients were included, of which 33 (28%) had ACS, with 27 (23%) being primary ACS and 6 (5%) secondary ACS. Twenty-eight-day mortality was higher in the ACS versus non-ACS group (52% versus 0%, $p < 0.001$) and overall hospitalization (64% versus 2%, $p < 0.001$). Primary fascial closure was achieved less often in ACS compared to non-ACS patients (46% versus 98%, $p < 0.001$). Bowel resection was more frequent in ACS versus non-ACS patients, approaching statistical significance (49% versus 30%, $p 0.056$).

Conclusion: During the study period, almost one third of children who underwent urgent exploratory laparotomy had ACS and 64% died. Children undergoing evaluation for acute surgical abdomen may benefit from routine intraabdominal pressure measurement.

Level of evidence: Level III retrospective comparative study

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Abdominal compartment syndrome (ACS) is an infrequent but serious clinical entity seen in critically ill children. The incidence is reported between 0.6% and 12.6% in pediatric patients [1,2]. Even after prompt medical treatment or definitive surgical treatment with decompressive laparotomy, mortality remains high [3,4]. Mortality from ACS in pediatric patients is currently reported between 25% and 85%, and without treatment approaches 100% [1–3,5]. Many conditions are associated with ACS. Primary ACS results from intraabdominal pathology such as: infectious enterocolitis, bowel obstruction, or bowel perforation, frequently requiring surgical or interventional radiological treatment. Secondary ACS results from conditions originating outside of the abdominopelvic compartment such as: sepsis, trauma, or burns, resulting in shock states and may be related to fluid resuscitation and edema of the abdominal compartment [6]. Following an inciting event

either in the abdominopelvic region (primary) or outside of the abdominopelvic region (secondary), ACS occurs from the development of sustained intraabdominal hypertension (IAH) that ultimately leads to cardiovascular and respiratory compromise [2,7,8].

Emergent exploratory laparotomy is standard of care in the evaluation and treatment of the acute surgical abdomen. It is unknown, however, what percentage of these patients is undergoing decompressive laparotomy for ACS and their outcome compared to those without ACS. Given the overlap in symptoms of acute surgical abdomen and ACS, it is possible that ACS is underrecognized in this patient population. The purpose of our study was to characterize the incidence of ACS in pediatric patients who underwent urgent exploratory laparotomy and to analyze the outcomes of patients with ACS compared to those without ACS during the study period. We hypothesized that patients with ACS would have worse outcomes compared with patients without ACS.

1. Materials and methods

We conducted a retrospective, single-center review of pediatric patients (birth–18 years) who underwent urgent exploratory laparotomy between January 1, 2013 and December 25, 2014. Patients met inclusion

Abbreviations: ACS, abdominal compartment syndrome; IAH, intraabdominal hypertension; ICU, intensive care unit; CPR, cardiopulmonary resuscitation; IS, index surgery; IAP, intraabdominal pressure; NEC, necrotizing enterocolitis; SBO, small bowel obstruction.

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criteria if they had an urgent laparotomy during the study period. Patient demographics were collected. Severity of illness was determined by organ dysfunction as evidenced by: admission to the intensive care unit (ICU), cardiopulmonary resuscitation (CPR) within 48 h of index surgery (IS), respiratory failure requiring mechanical ventilation, renal failure requiring hemodialysis, and hypotension requiring vasopressors/inotropes.

For the purpose of our study, ACS was defined as: abdominal distension with new onset or progression of organ dysfunction or failure in two or more organ systems; and/or with description in the surgical operative note of release of pressurized abdominal contents upon surgical incision. Primary and secondary ACS were defined according to current consensus guidelines [8]. We do not have intraabdominal pressure (IAP) data because IAP was not routinely obtained or monitored during this study period. Primary outcomes measured were mortality expressed as 28-day mortality and overall hospital mortality. Secondary outcomes included achievement of primary fascial closure and necessity of bowel resection. Patients were separated into three age groups for analysis: neonates (birth to 28 days of age), infants (29 days to 12 months of age), and children (greater than 12 months to 18 years of age). Primary and secondary outcomes were compared in patients who were identified as having ACS with those who did not.

2. Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics (Version 22; IBM Corporation 1989, 2013). Descriptive statistics were given as mean \pm standard deviation or median with minimum and maximum, for quantitative variables; and number with percentage for qualitative variables. Qualitative variables were compared by Pearson chi-square test and Fisher exact test when the assumptions of Pearson chi-square were not met. Independent samples Mann–Whitney U test was used to test if there was any difference between ACS and non-ACS patients in their age and weight at the time of IS. The patients were stratified by age, then the relationships between independent and dependent variables were examined. Alpha was set at 0.05 significance level.

3. Results

One hundred nineteen patients were reviewed, of which 68 (57%) were male. Thirty-three (28%) had ACS, with 27 (23%) being primary ACS and 6 (5%) secondary ACS as shown in Fig. 1. Patient characteristics are presented in Table 1. Of all patients reviewed, more than half were in the ICU prior to surgery. Mortality was significantly higher in the ACS group both overall (64%) and at 28 days (52%) compared to the non-ACS group (0% and 2%, respectively). Achievement of primary fascial closure was significantly higher in the non-ACS group. While not statistically significant, bowel resection was more frequent in the ACS group compared to the non-ACS group (Table 2). The most common diagnoses in the “Other” category were: intestinal perforation, appendicitis, and ovarian pathology.

3.1. Neonates

In the neonatal group, patients with ACS were older than the patients without ACS but had lower weight at surgery, indicating that this group likely had lower birth weight. The most common diagnostic category in the ACS group was necrotizing enterocolitis (NEC) compared to small bowel obstruction (SBO) and “Other” in the non-ACS group (Table 3). While all of the patients in both neonatal groups were in the ICU, the ACS group had greater severity of illness, as indicated by the requirement for more interventions such as mechanical ventilation and vasopressor/inotropic support.

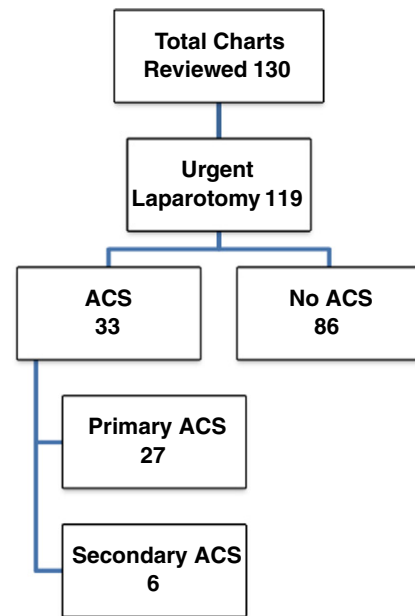


Fig. 1. Flow diagram of patients included in the study.

3.2. Infants

In the infant group, patients with ACS tended to be younger than the non-ACS group, but neither the age nor the weight was significantly different. Patients with ACS in this age group most commonly had NEC compared to SBO in the non-ACS group (Table 4). All of the patients in the ACS group were in the ICU and had greater severity of illness than the patients in the non-ACS group.

3.3. Children

In the children group, patients with ACS were younger, and the difference in weight likely reflects the younger age. Patients in the ACS group most commonly fell in the “Other” category. Patients in the non-ACS category most commonly had diagnoses that fell in the SBO and “Other” categories (Table 5). ACS patients had greater severity of illness, with 100% requiring ICU admission compared to just 13% of non-ACS patients.

4. Discussion

Despite increased awareness of ACS, IAP measurement is not routinely obtained in pediatric patients [9,10]. Therefore, it is possible

Table 1
Patient demographics.

Patient demographics	N (%)
Gender	
Female	51 (43)
Male	68 (57)
Diagnosis	
Small bowel obstruction	50 (42)
Ischemic	6 (5)
Trauma	11 (9)
NEC	18 (15)
Other	34 (29)
Intervention	
ICU admission	67 (58)
CPR	9 (8)
Mechanical ventilation	28 (24)
Hemodialysis	6 (5)
Vasopressor/inotropes	31 (27)

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