Postoperative Outcomes in Exploratory Laparotomy and Intestinal Resection in Children: A Secondary Descriptive Observational Analysis

Claudine Kumba (claudine.kumba@gmail.com)
Hôpital Universitaire Necker Enfants Malades, Assistance Publique Hôpitaux de Paris, APHP, Université de Paris

Research Article

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Abstract

Background: We previously reported independent predictors of intraoperative and postoperative morbidity. These were age, American Society of Anesthesiologists Score (ASA), emergency situations, surgery and transfusion. ASA was the independent predictor of mortality. We conducted a secondary analysis of this previous retrospective study in patients who underwent exploratory laparotomy and intestinal resection.

Objectives: To describe intraoperative and postoperative outcomes in patients who underwent exploratory laparotomy and intestinal resection in the initial study and to present a research protocol for intraoperative and postoperative optimization.

Methods: Secondary analysis of the initial study. The Ethics Committee approved the study.

Results: There were 54 patients with a median age of 15.5[0-172] months. Thirty-seven (68.5%) patients underwent intestinal resection, nine (16.7%) underwent exploratory laparotomy, and eight (16.8%) underwent laparotomy for volvulus.

Fourteen (25.9%) patients had intraoperative and/or postoperative complications. Two (3.7%) patients had intraoperative hemorrhagic shock. Two (3.7%) patients had postoperative cardio-circulatory failure. Three (5.6%) had postoperative respiratory failure. One (1.8%) patient had postoperative multiple organ failure and neurologic failure. Three (5.6%) patients had postoperative abdominal sepsis. One (1.8%) patient had postoperative multiple organ sepsis and neuromeningeal sepsis. Four (7.4%) patients had postoperative pulmonary sepsis. Two (3.7%) had postoperative septicemia. Six (11.1%) patients had reoperations. Seventeen (31.5%) patients had intraoperative transfusion.

The in-hospital mortality rate was 3.7% in two patients.

Conclusion: The number of patients with postoperative complications in this cohort was not negligible. We therefore elaborated a research protocol where intraoperative patient management will be guided with transthoracic echocardiography for fluid and hemodynamic therapy optimization. The objectives of this study protocol are to clarify the impact of intraoperative goal-directed fluid and hemodynamic therapy with transthoracic echocardiography on postoperative outcomes in terms of complications in pediatric surgical patients.

Introduction

Intraoperative and postoperative outcomes in children have been reported to be multifactorial (1-4). Reported independent predictors of intraoperative and postoperative complications were age, American Society of Anesthesiologists Score (ASA), emergency situations, surgery and transfusion (1-4). ASA was the independent predictor of mortality (1).

Intraoperative and postoperative complications in pediatric surgical settings with regard to age have been described previously (5-10). When considering the entire initial cohort of 594 patients, the overall rate of patients with intraoperative and/or postoperative complications was 23.9% (1). The most reported intraoperative complication was hemorrhagic shock, with an overall rate of 3.9% (1). The most commonly reported postoperative organ failure was neurologic, followed by respiratory, cardio-circulatory and multiple organ failure, with overall rates of 4.2, 3.5, 3 and 1.5%, respectively (1). The most commonly reported postoperative infection was septicemia, followed by pulmonary sepsis, abdominal sepsis, surgical wound sepsis and urinary sepsis, with overall rates of 3.7, 2.9, 2.7, 2 and 1.3%, respectively (1). Overall transfusion rate was 49.2%. Overall rate of reoperation was 7.2%. The rate of emergency interventions was 22.9%. Overall in-hospital mortality rate was 1.9%.

We conducted a secondary analysis of this initial cohort with the primary objective of describing intraoperative and postoperative outcomes in patients who underwent exploratory laparotomy and intestinal resection. The secondary objective was to propose and implement intraoperative optimization management research protocols for postoperative outcome improvement in these pediatric surgical settings.

Methods And Materials

A secondary analysis of patients who underwent exploratory laparotomy and intestinal resection was included in the initial study (1). In the initial study, we emphasized determining predictors of intraoperative and postoperative outcomes. In this secondary analysis, we aimed to emphasize the specific intraoperative and postoperative outcomes in a specific surgery, namely, laparotomy.

Outcomes were defined in terms of organ dysfunction, infection or sepsis, length of stay in the intensive care unit, length of hospital stay, length of total hospital stay (length of intensive care unit stay and length of stay in the standard hospitalization ward), duration of mechanical ventilation and transfusion.

Organ dysfunction and sepsis were defined per system with clinical, laboratory and imaging findings as a state of organ alteration not present in the preoperative period or present preoperatively with postoperative majoration or increase. Multiple organ dysfunction or multiple organ sepsis was defined as a state of more than one organ alteration with clinical, laboratory, and/or imaging findings.

The study was declared to the National Commission for Computer Science and Liberties (CNIL) under registration number 2028257 v0 on 21 February 2017 and approved by the Ethics Committee of Necker under registration number 2017-CK-5-R1 on 21 March 2017.

The inclusion criteria were patients who underwent exploratory laparotomy or intestinal resection and aged less than 18 years old included in the initial study.

The exclusion criteria were patients who did not undergo exploratory laparotomy or intestinal resection and were aged more than 18 years old.

Patients were included retrospectively from 1 January 2014 to 17 May 2017.

Statistics were analyzed with XLSTAT 2020.4.1. software. Continuous variables were expressed as medians with ranges or means with standard deviations. Category variables were described in proportions.

Results

Table 1 illustrates general characteristics.

There were 54 patients with a median age of 15.5[0-172] months and a median weight of 6.4[1.4-42] kilograms. There were four, twenty-four, twenty-two and four American Society of Anesthesiologists grade 1, 2, 3 and 4 patients, respectively. Thirty-two patients had an emergent intervention. Fourteen patients had intraoperative and/or postoperative complications. Two patients had intraoperative hemorrhagic shock. Two patients had postoperative cardio-circulatory failure. Three had postoperative respiratory failure. One patient had postoperative multiple organ failure and neurologic failure. Three patients had postoperative abdominal sepsis. One patient had postoperative multiple organ sepsis and neuromeningeal sepsis. Four patients had postoperative pulmonary sepsis. Two had postoperative septicemia. Six patients had reoperations. Seventeen patients had intraoperative transfusion. There were two in-hospital deaths. All patients with fatal outcomes had a comorbidity, namely, congenital heart disease, and all were managed on an emergency basis.

Table 2 illustrates the characteristics of patients with fatal outcomes.

Table 3 illustrates surgery.

Thirty-seven patients underwent intestinal resection, nine underwent exploratory laparotomy, and eight underwent laparotomy for volvulus.

Table 4 illustrates the co-morbidities.

The most common comorbidities were congenital coagulation disorders, congenital heart disease, necrotizing enterocolitis, cancer, Hirschsprung’s disease, hepatic failure, intestinal pseudoocclusion, neurofibromatosis, and preterm birth.

Discussion

The rate of patients with intraoperative and/or postoperative complications in this secondary analysis was comparable to that of the initial cohort (1-4). This was not surprising since this cohort was a subcohort of the initial study. The results of this secondary analysis highlight that morbidity in terms of postoperative organ dysfunction and infection in patients who underwent exploratory laparotomy and intestinal resection was high. Similar analyses have been conducted in other surgical pediatric settings (5-15). How could these outcomes be improved? We conceptualized a research protocol where intraoperative fluid and hemodynamic therapy will be guided with transthoracic echocardiography to optimize intraoperative patient status (16,17). Echocardiography has been validated in several pediatric studies to guide fluid therapy in children (18-22). The objectives of intraoperative goal-directed fluid and hemodynamic therapy are to optimize patient status to improve postoperative outcomes (23,24). In adults, goal-directed fluid and hemodynamic therapy has been shown to reduce postoperative morbidity, mortality and length of hospital stay in surgical patients (25). In children, the impact of goal-directed fluid and hemodynamic therapy has not yet been demonstrated. Our hypothesis is that goal-directed therapy with validated tools in children, such as echocardiography, could also improve postoperative outcomes in pediatric surgical patients (16,17). In our hospital, goal-directed fluid and hemodynamic therapy with transthoracic echocardiography is not yet a routine practice in major surgery. This research protocol will clarify the impact of intraoperative echocardiography for fluid and hemodynamic therapy on postoperative outcomes in surgical pediatric patients.

One-third of the patients in this subcohort were transfused. Transfusion is also an important aspect in intraoperative management. Transfusion has been shown to be an independent predictor of postoperative morbidity (1-4). Optimizing intraoperative transfusion with point-of-care viscoelastic methods has been shown to reduce transfusion requirements and decrease the length of hospital stay in pediatric hemorrhagic surgical settings (26). Goal-directed therapies include fluid and hemodynamic therapy with validated tools in children and transfusion goal-directed protocols guided with point-of-care tests. These goal-directed therapies have in common the aim of optimizing the relationship between oxygen consumption and oxygen delivery to avoid situations where oxygen consumption becomes dependent on oxygen delivery (23,24). Situations where oxygen consumption becomes oxygen delivery dependent predispose patients to organ dysfunction (23,24). Oxygen delivery is determined, among other factors, by cardiac output and hemoglobin levels. Goal-directed fluid and hemodynamic therapy with echocardiography has the objective of optimizing cardiac output, which is a determinant of oxygen delivery (23,24). Transfusion protocols guided with point-of-care tests have the objective of optimizing blood product administration to transfuse the right product at the right time. Optimal hemoglobin levels are necessary for an optimal oxygen consumption-oxygen delivery relation (23,24). Our hypothesis is that intraoperative optimization with goal-directed therapies could contribute to upgrading postoperative outcomes in these major surgical settings. To date, goal-directed therapies are not well developed in children. A systematic review and meta-analysis in children revealed that indirect nonoptimal biomarkers of oxygen consumption-oxygen delivery, namely, lactate levels, regional oxygen saturation, and mixed venous oxygen saturation, were predictors of adverse postoperative outcomes in major pediatric surgical patients in terms of morbidity, mortality and length of hospital stay (27). We have elaborated a study protocol with transthoracic echocardiography for intraoperative fluid and hemodynamic therapy optimization. This protocol will clarify the impact of this validated tool on postoperative outcomes in pediatric surgical patients (16,17). Similar conclusions have been drawn in other major pediatric surgical settings where goal-directed therapies need to be developed in research protocols to determine their impact on postoperative outcomes (11-15).

Conclusion

The number of patients with postoperative complications in this cohort was 25.9%. To improve these outcomes, we elaborated a research protocol with transthoracic echocardiography**.** Intraoperative goal-directed therapies need to be developed in research protocols in these major pediatric surgical settings to determine their impact on intraoperative and postoperative outcomes.

Declarations

Conflicts of Interest: The author declared no conflicts of interest.

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Author contributions: Claudine Kumba conceptualized and designed the study and drafted the

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Ethics Approval: This study received approval from the Ethics Committee of Necker on 21 March 2017 under registration number 2017-CK-5-R1 and waived patient consent.

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Tables

Table 1 General characteristics

Characteristic	**N=54**
Median age [range] in months	15.5[0-172]
Median weight [range] in kilograms	6.4[1.4-42]
ASA I n (%)	4(7.4)
ASA II n (%)	24(44.4)
ASA III n (%)	22(40.7)
ASA IV n (%)	4(7.4)
Emergency surgery n (%)	32(59.3)
Elective surgery n (%)	22(40.7)
Re-operation n (%)	6(11.1)
Patients with intra-operative and or postoperative complications (organ failure or sepsis) n (%)	14(25.9)
Intraoperative hemorrhagic shock n (%)	2(3.7)
Postoperative cardio-circulatory failure n (%)	2(3.7)
Postoperative respiratory failure n (%)	3(5.6)
Postoperative multiple organ failure n (%)	1(1.8)
Postoperative neurologic failure n (%)	1(1.8)
Postoperative abdominal sepsis n (%)	3(5.6)
Postoperative multiple organ sepsis n (%)	1(1.8)
Postoperative neuro-meningeal sepsis n (%)	1 (1.8)
Postoperative pulmonary sepsis n (%)	4 (7.4)
Postoperative septicemia n (%)	2(3.7)
In-hospital mortality n (%)	2(3.7)
Transfusion n (%)	17(31.5)
Median packed red blood cells volume in ml [range]	0[0-5]
Median fresh frozen plasma volume in ml [range]	0[0-2]
Median concentrated platelet units [range]	0[0-2]
Mean preoperative hemoglobin levels ± standard deviation in g/dL	12.6±3.3
Mean postoperative hemoglobin levels ± standard deviation in g/dL	11.3± 1.9
Median crystalloid volume in ml [range]	1287.5[60-3100]
Median colloid volume in ml [range]	0[0-1000]
Median length of intensive care unit stay in days [range]	5[0-77]
Median length of hospital stay in days [range]	7[0-101]
Median total length of hospital stay in days [range]	15[4-178]
Median total length of mechanical ventilation in days [range]	0[0-28]

Table 2 Patients with fatal outcome

ry	Age in days	ASA score	Co-morbidities	Intra-operative complications	Postoperative outcome	Delay of in-hospital mortality in days	Emergency	Transfusion
otomy vulus	30	4	Congenital Heart Disease	0	Multiple Organ Sepsis	75	1	No
nal ion	<28	3	Congenital Heart Disease	0	Multiple Organ Failure and Neuro-meningeal sepsis	63	1	1

Table 3 Surgery

Surgery	Number of (%)
Intestinal resection	37 (68.5)
Exploratory laparotomy	9 (16.7)
Laparotomy for Volvulus	8 (14.8)

Table 4 Co-morbidities

Co-morbidity	Number of patients(%)
Bronchodysplasia	1(1.8)
Cancer	3(5.6)
Congenital coagulation disorder	10(18.5)
Congenital heart disease	4(7.4)
Crohn's disease	1(1.8)
Duodenal atresia	1(1.8)
Former preterm	1(1.8)
Hepatic failure	2(3.7)
Hepatoblastoma	1(1.8)
Hirschprung	3(5.6)
Intestinal pseudo-occlusion	2(3.7)
Necrotizing enterocolitis	4(7.4)
Neurofibromatosis	2(3.7)
Polymalformation syndrome	1(1.8)
Polytrauma	1(1.8)
Pre-term	2(3.7)
Pre-term+Necrotizing enterocolitis	2(3.7)
Transplantation	1(1.8)