



Profound systemic inflammatory response syndrome following non-emergent intestinal surgery in children[☆]

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Abstract

Purpose: Systemic inflammatory response syndrome (SIRS) is an uncommon but severe complication in surgical patients. While SIRS is well known, it is poorly described in the pediatric population. The goal of this study was to describe the incidence of profound SIRS following non-emergent intestinal surgery in children and to identify potential risk factors.

Methods: A retrospective review was conducted for patients 0–19 years of age following intestinal surgery and/or lysis of adhesions from 01/01/1999–02/28/2012. Children were excluded for preoperative instability or frank bowel perforation. Patients were then placed in a post-operative SIRS or non-SIRS group as defined by the 2005 International Pediatric Sepsis Consensus Conference Guidelines (6. B. Goldstein, B. Giroir, A. Randolph, and Sepsis International Consensus Conference on Pediatric, 'International Pediatric Sepsis Consensus Conference: Definitions for Sepsis and Organ Dysfunction in Pediatrics', *Pediatr Crit Care Med*, 6 (2005), 2–8.).

Results: SIRS was identified in 17 of the 381 patients. Logistic regression analysis was performed and showed heart disease, kidney disease, PN dependence, and intestinal obstruction to be predictive of post-operative SIRS.

Conclusion: This study represents one of the first reports to identify a previously poorly described process of significant SIRS after intestinal surgery in children. Both systemic organ failure and intestinal dysfunction are strong risk factors for post-operative SIRS in children. Potentially, these pre-existing conditions may lead to disruption of normal intestinal flora or barrier function, which in turn may predispose these children to dramatic SIRS episodes after intestinal surgery. Understanding how these factors lead to SIRS will be critical to developing prevention strategies.

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Intense systemic inflammatory response syndrome (SIRS) following non-intestinal surgeries has been documented in the literature predominately in adults who are

otherwise healthy patients [1–3]. This has been characterized in children, but to a far lesser degree [4]. Importantly, significant SIRS following bowel resections or lysis of adhesions, in the absence of infection, bowel perforation or necrosis has not been described in the literature. The etiology of these SIRS events also remains poorly understood. Sudden, inexplicable instability or shock following what should be a routine surgery can lead to lasting morbidity or even death. Integral to treating shock is addressing the

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underlying source. Thus, identifying risks and causative factors may allow physicians to better optimize patients preoperatively, manage patients perioperatively and possibly prevent this detrimental outcome from occurring.

Isolated cases of profound postoperative stress responses or SIRS following intestinal resection or adhesiolysis have been anecdotally noted by pediatric surgeons at the C.S. Mott Children's Hospital. However, it is not clear how frequently such an event occurs in children. The goals of this study include attempting to determine overall incidence of postoperative SIRS by examining all infants and children undergoing non-emergent intestinal resection or adhesiolysis over the past 13 years as well as identifying potential contributing factors.

1. Methods

Approval for this study was obtained through the institutional IRB prior to any data collection (HUM00056147). Patients between the ages of 0 and 19 years old who underwent intestinal (small and/or large bowel) surgery or lysis of adhesions from 01/01/1999-02/28/2012 were identified using a search of billed procedures for all pediatric surgeons at our institution within the electronic medical charting system. Specifically, the terms include: "entrectomy", "colectomy", "bowel resection", "lysis of adhesions", "enterolysis" and "adhesiolysis." The patients of interest from this list were children that were not already predisposed towards postoperative instability. Thus, patients that were significantly unstable preoperatively or were being operated on for frank bowel perforation or intestinal necrosis were excluded. A retrospective review was then conducted identifying patients that postoperatively exhibited a severe Systemic Inflammatory Response Syndrome (SIRS) or shock (septic or septic shock-like syndrome). The definition of severe sepsis and septic shock were taken from the landmark paper "International pediatric sepsis consensus conference: Definitions for sepsis and organ dysfunction in pediatrics" [5]. However, as not all patients in a state of significant SIRS had identifiable sources of infection, instead of using the terms "severe sepsis" or "septic shock" to define the post-operative course of children within the study group, the terms of "severe SIRS" and "SIRS related shock" are used instead. These terms indicate states of inflammation identical to severe sepsis and septic shock, but in the absence of defined infection, similar to what has been coined already in the adult population [6]. As stated above, patients with obvious intra-abdominal sources of post-operative severe sepsis or septic shock such as frank perforation and luminal leaks were also excluded. Children that met these criteria made up the study group (SIRS group). The remaining children were placed in the control group (Non-SIRS group). The two groups were then compared using univariate analysis (Fisher's Exact test) to identify potential risk factors of a significant post-operative SIRS. Statistical

significance was defined as an alpha value of 0.05. A secondary logistic regression analysis was also performed (SPSS version 19.0) on key risk factors identified by univariate analysis, in order to exclude confounding covariates. These latter results are reported as the beta coefficient and *P* value.

Gender, age, length of stay, type of surgery, indication for surgery, past medical history, immunosuppression, past surgical history, and route of nutrition were the major categories compared between the two groups. The types of surgical procedures were divided into small bowel surgery, colonic surgery, and lysis of adhesions only. Operations included intestinal resections, anastomoses, enteroplasties, and/orotomy manipulation. These surgeries were then placed into their respective category based on location. Surgical indications were separated into categories of bowel atresia, adhesive or strictured small bowel obstruction, adhesive or strictured colonic obstruction, enterocutaneous fistula, gastrointestinal bleed, intussusception, mass, unwanted stoma, imperforate anus, short gut syndrome, inflammatory bowel disease and other. The "other" category grouped the following indications together: meconium ileus, dysmotility, abdominal pain, blunt trauma causing mesenteric disruption, gastroesophageal reflux disease, incarcerated congenital diaphragmatic hernia, choledochal cyst, cloacal exstrophy, and malrotation. Within the past medical history category, included variables were history of chronic organ dysfunction such as heart disease (congenital heart defects), lung disease, mental disorders, kidney disease, or liver disease, as well as history of prematurity and/or malignancy. Intestinal derangements were also analyzed, and included: history of inflammatory bowel disease, dysmotility, short gut syndrome and/or history of infectious bowel disease. Infectious bowel disease indicated a history of *Clostridium difficile* or enterocolitis. Past surgical history categories included previous bowel surgery, other abdominal surgeries, heart surgery, and kidney or liver transplants. Mode of nutrition was categorized by enteral intake and use of parenteral nutrition (PN). Enteral intake was defined as any type of oral or enteral consumption or nutrition via tube feeds, including clear liquids. Patients were then demarcated into two categories based on no enteral intake for a week or more. Similarly, PN was defined as any intravenous nutrition, whether supplied peripherally or through a central line. Patients were then separated into two categories: those that were PN dependent and those that were not.

2. Results

Four hundred sixty-four patients were identified in the initial review. Patients were immediately excluded (*N* = 83) for a lack of data or based on the defined exclusion criteria (Methods). Of these, 17 children were found to have severe SIRS post-operatively and comprised the SIRS group. The

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