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Identifying strategies to decrease infectious complications of gastroschisis repair

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ABSTRACT

Purpose: We describe the infectious complications of gastroschisis in order to identify modifiable factors to decrease these complications.
Methods: Data from 155 gastroschisis patients (2001–2013) were reviewed. Complicated gastroschisis (intestinal atresia, necrotic bowel, or perforation) were excluded, leaving 129 patients for review. Patient demographics, surgical details, postoperative infections and complications, and length of stay were reviewed. We used CDC definitions of infectious complications.
Results: The average gestational age of patients was 35.97 weeks. Silos were used in 46% of patients (n = 59) for an average of 7.4 days. Thirty-one patients (24%) acquired an infection within the first 60 days of life. Patients who developed an infection were born earlier in gestation (P = 0.02), weighed less (P = 0.01), required silos more often (P = 0.01), and received a sutured repair (P = 0.04). Length of stay of patients with an infection was longer than in patients without infection (P = 0.01).
Conclusions: Infectious complications following gastroschisis repair are common. Subsets of gastroschisis patients at increased risk of infection include patients with silos, preterm delivery, low birth weight, and sutured repair. Based on our findings, our recommendation would be to carry gastroschisis patients to term and advocate against the routine use of silos, reserving their use for those cases when primary closure is not possible.

Gastroschisis is the congenital right-sided paraumbilical defect allowing protrusion of intestines and other abdominal viscera out of the abdominal cavity. This condition is present in approximately 1 in 4000 live births [1]. Subsets of gastroschisis patients have been reported to be at a higher risk of infections and complications [1–6]. The purpose of this study was to identify risk factors for infectious complications in an attempt to prevent these complications. The primary outcome of interest in this study was the development of in-hospital infectious or antibiotic complications within the first 60 days of life.

1. Methods and materials

1.1. Patient population and data collection

This study reviewed gastroschisis patients cared for at Children's Hospital and Medical Center and The University of Nebraska Medical Center (Omaha, NE) from 2001 until 2013. Patients were identified via a prospective database initiated in 2001 (Table 1). Patients born with complicated gastroschisis (defined below) were excluded from this study. Database variables collected included gestational age, mode of delivery, method of gastroschisis closure, length of silo usage, number of days with a CVL/PICC, days on TPN, length of stay, and birth weights. The charts were then retrospectively reviewed and additional data recorded included: infectious complications, antibiotic duration, complications of antibiotic usage, and antibiotic blood levels. These data were recorded for the first 60 days of life. Infectious complications prior to this were likely related to the underlying disease (gastroschisis). Complications after this were more likely related to prolonged NICU hospitalization. Our median length of stay was 36 days, and thus, 60 days would cover the majority of all patients' hospitalizations.

1.2. Operative management

An attempt was made to perform a primary closure on all gastroschisis patients. This was done at the bedside after intubation or in the operating room at the surgeon's discretion. If the bowel did not reduce easily, a silo was placed. Pressures (gastric or bladder) were not routinely measured. Tidal volumes and peak airway pressures were monitored during attempted closure. Type of closure (sutured or sutureless) was determined by the surgeon. Sutureless closure was first used in 2007 and was used in both primary repairs and after silo placement at the discretion of the attending surgeon. The sutureless

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Table 1
Database demographics.

	Entire database n = 129
Sex	
Male	75 (58%)
Female	54 (42%)
IUGR rate	18 (14%)
Delivery method	
Cesarean section	92 (71%)
Vaginal delivery	37 (29%)
Carried to term	
Yes	48 (37%)
No	81 (63%)
Silo	
Yes	59 (46%)
No	70 (54%)
Mean length	7.42 ± 2.4 days
CVL days	39.8 ± 29.9 days
Length of stay	45.38 ± 32.3 days

technique involves leaving a long umbilical cord, coiling it over the defect, and placing an occlusive dressing over the wound. The dressing is changed at five days.

1.3. Definitions

Gastroschisis patients were classified as either simple or complicated. Complicated gastroschisis was defined as those patients with intestinal atresia, necrotic bowel, or perforation. Prematurity was defined as less than 37 weeks gestation. Intrauterine growth restriction (IUGR) was defined by a birth weight at or below the 10th percentile for gestational age. Initial antibiotics were defined as antibiotics prescribed at birth, prior to detection of infection. Initial antibiotics were continued at the discretion of the attending surgeon. In some cases where infectious complications developed, this led to an extended course of antibiotics. Duration of initial antibiotics was defined as the length of time initial antibiotics were continued. We used standard CDC definitions for infectious complications (Table 2).

1.4. Statistical analysis

Results were expressed as mean ± SD or proportions as appropriate as well as ranges where appropriate. Relative risks were also assessed where appropriate. Variables with skewed distributions are presented as medians with interquartile ranges. Our comparisons were conducted using the Mann–Whitney test for continuous data and the Fisher's exact test for categorical data. A P-value of less than 0.05 was considered statistically significant.

1.5. IRB approval

This study was approved by the University of Nebraska Medical Center–Joint Pediatric Institutional Review Board (##445-09-EP).

2. Results

One hundred fifty-five patients were cared for with gastroschisis between August 2001 and June 2013. After excluding patients born with complicated gastroschisis, 129 patients remained for analysis. Fifty-eight percent (n = 75) of patients were male. The mean length of stay was 45.4 days (median: 36). Eighty-one (62.8%) patients were born preterm (<37 weeks). Seventy-one percent (n = 92) of patients were born via cesarean section. The high rate of cesarean sections in this study is largely because of the practice of elective preterm delivery of gastroschisis patients, which was common prior to review of these data at our institution. Silos were used in 46% of patients (n = 59) for a mean duration of 7.4 days. Fourteen percent of patients were born with IUGR (Table 2).

Table 2
Definitions of infectious complications.

Surgical site infection	An infection of the skin and/or tissues surrounding the surgical site, characterized by the presence of erythema, localized swelling, and purulent drainage
Central line associated blood stream infection	An infection occurring when bacteria or viruses enter the bloodstream via a patient's central line, characterized with a fever, erythema, and soreness around the CVL, as well as a positive blood culture
Urinary tract infection	An infection involving any part of the urinary system, often developed in association with a urinary catheter and characterized by the presence of fever, apnea, bradycardia, dysuria, and lethargy
Ventilator associated pneumonia	A lung infection developing in patients on a ventilator caused by viruses or bacteria entering the ventilator tubing and entering the lungs of the patient
Ventilator associated tracheobronchitis	A localized disease characterized by the presence of a fever, purulent sputum, and a fever and accompanied by a cultured causative pathogen
Aspiration pneumonia	Inflammation of the lungs caused by inhaling or choking on vomit
Sepsis	The presence of bacteria and their toxins in the body, causing widespread inflammation, characterized by the presence of a fever, accelerated heart rate or respiratory rate, as well as the presence of a confirmatory laboratory test for infection
Peritonitis	Inflammation of the peritoneum caused by bacterial infection via the blood or rupture of an abdominal organ
Necrotizing enterocolitis	A bacterial infection of the intestine, most often observed in preterm and small for gestational age (SGA) babies with a diagnosis being made by using Bell's Staging which looks at radiographic findings of pneumatosis and portal venous gas as well as clinical finds of abdominal distention, hematochezia, and hemodynamic instability
Phlebitis	Inflammation along the course of a vein, often related to a PICC or CVL
Stitch abscess	A localized collection of pus in the area where stitches were placed, caused by microorganisms invading the tissues

Twenty-four percent of patients acquired one or more infections during the first 60 days of life (n = 31/129), the most prevalent infections being sepsis (n = 12), surgical site infections (n = 11), and central line associated blood stream infections (n = 8). The average day of infection development was day of life 26.2. Organisms were identified in 26 of the 44 infections identified in this study. Surgical site infections were caused by *Candida albicans* (n = 3) and *Staphylococcus aureus* (n = 3). Central line associated blood stream infections were caused by a variety of infections, but most commonly by *S. aureus* (n = 4). Sepsis was most often caused by Staphylococcus (n = 3) (Table 3).

Antibiotic complications were experienced in 6.2% of patients (n = 8/129). Complications of antibiotics in this study included oral thrush and candidal rash. Two patients presented with oral thrush, five presented with candidal rash, and one patient was diagnosed with both oral thrush and a candidal rash. Patients on average had 3.4 gentamicin level tests during the first 60 days of life. These tests added an average of $361.29 to cost of care.

Initial ampicillin and gentamicin were prescribed to 97% (n = 125) of patients, with the remaining four patients receiving ampicillin, gentamicin, and cefazolin. The infection rate was not found to be significantly different between these prescribed courses, although the groups differed significantly in size making it difficult to draw conclusions from the data. Initial antibiotics were prescribed for a duration ranging from 48 hours to 34 days, for an average of 9.8 days. Eight patients received 48 hours of initial antibiotics, all of which were primarily closed. Patients with silos were given initial antibiotics approximately seven days longer than patients primarily closed (13.0 vs. 7.2 days, P = 0.01).