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Effective methods to decrease surgical site infections in pediatric gastrointestinal surgery

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ABSTRACT

Background: Gastrointestinal (GI) surgeries represent a significant proportion of the surgical site infection (SSI) burden in pediatric patients, resulting in significant morbidity. Previous studies have shown that perioperative bundles reduce SSIs, but few have focused on pediatric GI operations. We hypothesized that a GI bundle would decrease SSI rates, length of stay (LOS), and hospital charges.
Methods: After establishing baseline SSI rates, a GI bundle was created and implemented in November 2014. We prospectively collected data including demographics, procedure type, LOS, inpatient charges, bundle compliance, and SSI development. We analyzed SSI rates, LOS, and charges using process control charts.
Results: The baseline SSI rate for all GI operations was 3.4%, which increased to 7.1%, then decreased to 4.7%. Midgut/hindgut and stoma closure SSI rates decreased from 11.3% to 8.0% ($p < 0.05$) and 21.4% to 7.9%, respectively ($p < 0.05$). Although overall LOS and charges were unchanged, average LOS for midgut/hindgut surgeries and stoma closures decreased from 20.3 to 13.6 days ($p = 0.015$) and 12.6 to 7.9 days ($p = 0.04$), respectively. Stoma closure charges decreased from $94,262 to $50,088 ($p = 0.01$).
Conclusions: Our perioperative GI bundle decreased SSI rates, primarily among midgut/hindgut operations. Bundle usage decreased LOS and charges most effectively in stoma closures.
Type of study: Prognosis Study.
Level of evidence: Level 2.

Surgical site infections (SSIs) represent a common source of postoperative morbidity and mortality. Their development contributes to increased length of stay (LOS), increased hospital costs, and decreased quality of life [1–6]. Gastrointestinal (GI) operations comprise a significant proportion of this overall disease burden [2]. Multiple risk factors for SSI have been identified in adults including hypothermia, hyperglycemia, obesity, medical comorbidities, and wound classification; to the extent that these factors can be prevented or minimized, SSI rates can be reduced [7–10]. Appropriate preoperative skin preparation and antibiotic administration have also been shown to decrease the incidence of SSI [11,12]. For colorectal operations, the usage of a bowel preparation may also reduce infection rates. Adult studies suggest that the combination of a mechanical bowel prep and oral antibiotics decreases SSIs, whereas a mechanical prep alone may have the opposite effect [1,13,14]. For bowel prep, as for many other specific SSI-reducing practices, the majority of evidence comes from studies in adult patients. Although pediatric surgeons often apply adult principles to their patients, a dedicated pediatric focus is sorely needed.

Many of these practices can be combined into perioperative bundles, which minimize variation in patient care. Several studies have demonstrated that perioperative care bundles effectively decrease SSI rates in adults undergoing colorectal surgery [15,16]. The body of literature surrounding pediatric perioperative bundles is growing, and multicenter studies have demonstrated that bundles reduce SSI rates in pediatric spine, cardiac and neurosurgical procedures [17,18]. Additionally, recognizing that stoma closures typically have exceptionally high SSI rates, a recent study showed that bundle usage reduced stoma closure SSI rates in pediatric patients [19]. Since SSIs incur a significant medical

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Table 1
GI surgery perioperative bundle.

Preop Bowel Prep

- Bowel prep required for all patients undergoing a procedure involving the rectum unless a proximal stoma is present and is not being concomitantly reversed
- Inpatient regimen
  - o GoLytely 25 mL/kg/h × 4 h
  - o Neomycin 15 mg/kg/dose (×3 doses)
  - o Erythromycin 20 mg/kg/dose (×3 doses)
    - ▪ 10 mg/kg/dose for neonates <30 days old

Preop Cleansing

- Patients >2 months: clean the abdomen with 2% chlorhexidine gluconate wipes
- Patients <2 months: clean the abdomen with antimicrobial wipes

Preop Warming

- Measure patient temperature 1 h prior to operation
- Apply convection warming blanket for all patients with initial temperature < 36.5 °C
  - o Recheck temperature every 30 min

Preop Antibiotics

- Administer appropriate antibiotic to finish within 60 min of incision
  - o Cefazolin for foregut and HPB procedures. Redose as needed
  - o Cefoxitin for midgut/hindgut procedures. Redose as needed
    - ▪ Gentamicin/clindamycin for patients with penicillin allergies
    - ▪ Ampicillin/gentamicin acceptable for neonates within first week of life; add clindamycin after first week
  - o If patient is on adequate systemic antibiotics prior to the procedure, no additional antibiotics are needed. Redose as needed

Skin Prep

- Chlorhexidine for all patients >2 months or >1 kg
- 10% povidone-iodine for patients <2 months or <1 kg

Closing Protocol (for procedures in which the bowel has been opened and fascial closure is needed)

- Prior to fascial closure:
  - o All staff change gloves
  - o Redrape the surgical field
  - o Remove all dirty instruments; use clean instruments for fascia and wound closure

and financial burden, we developed a comprehensive perioperative GI bundle to decrease SSI rates, and hypothesized that its use would in turn result in decreased overall LOS and inpatient hospital costs.

1. Methods

1.1. Patient data collection

We determined baseline 30-day SSI rates from January 2014 to November 2014 through a retrospective chart review of all patients undergoing GI surgeries at a tertiary care free-standing pediatric hospital. We defined SSIs according to accepted Centers for Disease Control definitions [20]. Since then, we have continued to prospectively review the charts of all patients undergoing GI surgeries. Data points collected include age, sex, body mass index (BMI), ASA class, pre-operative location, procedure performed, total hospital LOS, intensive care unit (ICU) LOS, number of ICU admissions, total number of GI operations, and total 30-day inpatient charges. Procedures were broadly categorized as either "Foregut," "Hepatopancreaticobiliary (HPB)," or "Midgut/Hindgut," and also as elective, urgent, or emergent. Appendectomies and trauma operations were excluded.

1.2. Bundle development

Based on best practice recommendations from the adult literature, we developed a perioperative bundle for all GI surgeries, which went into effect in November 2014 (Table 1). The bundle was subsequently modified in January 2016 to include closing protocol for all stoma closures. We monitored and analyzed bundle compliance on a monthly basis beginning in August 2014, to establish baseline practice patterns. We also provided ongoing feedback to improve compliance with all bundle components.

1.3. Data analysis

SSI rates were calculated as the number of infections divided by the total number of GI procedures for each month, and were tracked over time using Shewhart process control charts. Separate SSI rates were calculated for each procedure category, with special attention to midgut/hindgut procedures and stoma closures, since these groups generally have higher reported SSI rates [2,9]. With these charts, baseline and process stage means are established based on an absolute minimum of 6 consecutive values, although process stages may extend longer provided that they reasonably explain variation among the contained data points. Control limits are set at 3 standard deviations from the mean. Variation within the control limits is considered acceptable, or common cause variation, whereas points outside these limits represent special cause variation and imply an external confounding factor. For each

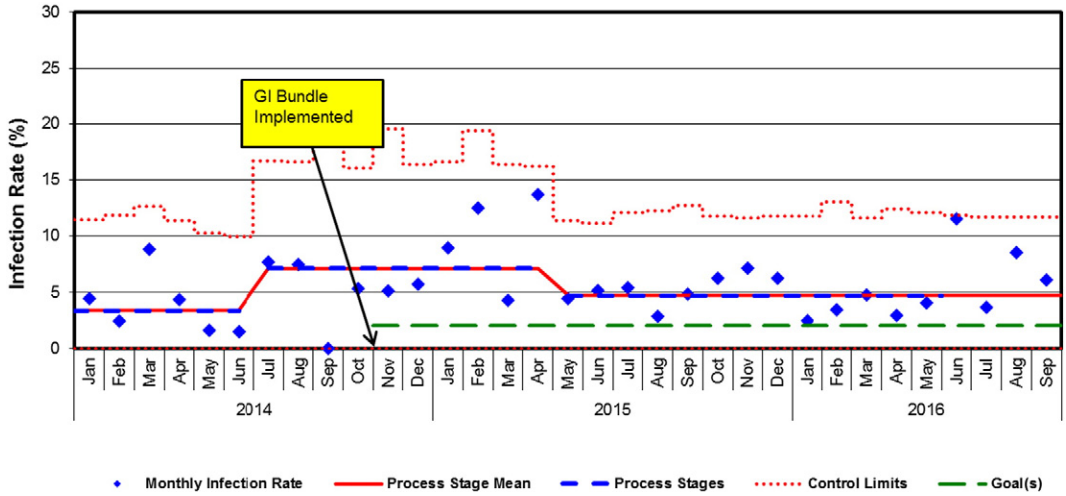

Fig. 1. Overall SSI rates for all GI surgeries. Control limits are set at 3 standard deviations from the mean. Process means are established based on a minimum of 6 consecutive values, and shifts in the process mean are significant at the $p = 0.05$ level.

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