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## Impact of Multidisciplinary Standardization of Care for Gastroschisis: Treatment, Outcomes, and Cost<sup>☆,☆☆</sup>

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## ABSTRACT

**Background/Purpose:** Elimination of unnecessary practice variation through standardization creates opportunities for improved outcomes and cost-effectiveness. A quality improvement (QI) initiative at our institution used evidence and consensus to standardize management of gastroschisis (GS) from birth to discharge.

**Methods:** An interdisciplinary team utilized best practice evidence and expert opinion to standardize GS care. Following stakeholder engagement and education, care standardization was implemented in September 2014. A comparative cohort study was conducted on consecutive patients treated before (n = 33) and after (n = 24) standardization. Demographic, treatment, and outcome measures were collected from a prospective GS registry. Direct costs were estimated, and protocol compliance was audited.

**Results:** BW, GA, and bowel injury severity were comparable between groups. Key practice changes were: closure technique (pre-88% primary fascial, post-83% umbilical cord flap; p < 0.001), closure location (pre-97% OR, post-67% NICU; p < 0.001), and GA avoidance (pre-0%, post-48%; p < 0.001). Median post-closure ventilation days were shorter (pre-4, post-1; p < 0.001), and SSI rates trended lower (pre-21%, post-8%; p = 0.3) in the post-implementation group with no differences in TPN days or LOS. No significant difference was seen in average per-patient costs: pre-\$85,725 (\$29,974–221,061), post-\$76,329 (\$14,205–176,856).

**Conclusion:** Care standardization for GS enables practice transformation, cost-effective outcome improvement, and supports an organizational culture dedicated to continuous improvement.

**Level of Evidence:** III.

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Gastroschisis (GS) is among the commonest of structural congenital anomalies, with an incidence of approximately 1 per 2200 live births [1,2]. Due to the very high rates of prenatal diagnosis [3], babies born with gastroschisis are immediately admitted to a neonatal intensive

care unit (NICU), where several provider disciplines (neonatology, pediatric surgery, pediatric anesthesia, specialized newborn nursing) work collaboratively to provide optimal care. Although survival rates are well above 90% in developed countries, morbidity may still be significant and NICU stays may be long and resource intensive [4]. The high cost of care of babies with GS relative to other NICU patient populations is well established [5,6], and there is recent evidence that amongst pediatric surgical diagnoses, GS is responsible for a substantial proportion of inter-hospital cost variation [7].

Several barriers to the optimization of care and outcomes for a complex malformation such as GS exist. These include: 1) a lack of high level and high quality evidence to inform best clinical practices; 2) challenges in seamless integration of multidisciplinary care; and 3) unwanted practice variation, which may be an undesirable consequence of non-standardized care [2,8–14]. To address these barriers,

**Abbreviations:** QI, quality improvement; GS, gastroschisis; SSI, surgical site infection; GPS, gastroschisis prognostic score; EOS, early onset sepsis; TPN, total parenteral nutrition; NICU, neonatal intensive care unit; GA, general anesthesia; OR, operating room; CIHI, Canadian Institute of Health Information; Cdn\$, Canadian dollars.

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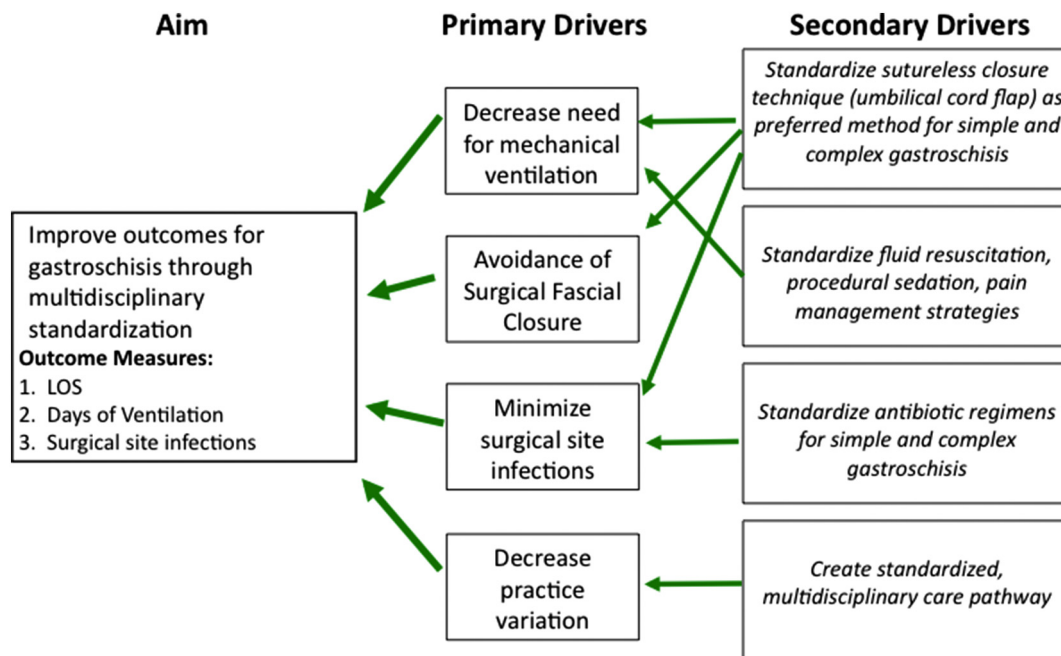
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**Fig. 1.** This figure depicts the key drivers diagram which illustrates the critical concepts, both primary and secondary, driving the putative changes in desired outcome measures. LOS: length of stay.

with the goal of achieving improved outcomes, we developed and implemented a standardized, multidisciplinary care pathway for GS, and compared patients who were treated before and after pathway implementation.

## 1. Materials and methods

A multidisciplinary working group with representation from pediatric surgery, neonatology, anesthesia, neonatal nursing, and antibiotic stewardship was struck. A quality improvement (QI) charter was developed with an aim of improving outcomes for all patients with GS within 24 months of implementation of a standardized, multidisciplinary care pathway. The clinical outcome improvement targets were a reduction of days of mechanical ventilation and LOS by 10% and a reduction in rates of surgical site infection (SSI) by 20%. A driver diagram which established links between targeted interventions and outcomes was created (Fig. 1).

The working group conducted literature reviews and summarized evidence which could be used to inform best practice in the following care domains: bowel protection after birth, vascular access and intravenous therapy (solution and infusion rate), type and duration of antibiotic therapy, technique of abdominal closure, and procedural sedation strategies. In addition, an environmental scan of standardized clinical pathways in use at other children's hospitals was conducted, and these were used as comparators in the development of our pathway.

### 1.1. Stakeholder engagement

The incentive for this standardization project was a decision by the surgical group, consisting of five surgeons, to make umbilical cord flap closure the preferred closure technique. Joint rounds with the neonatologists and perinatologists led to group consensus on a decision to adopt a closure technique that would uphold general anesthesia (GA) avoidance as risk mitigation against potential neurotoxicity associated with GA in newborns. Presentations on the technique of cord flap closure were disseminated throughout the NICU. This led to amendments to educational and policy and procedure documents which created a new nursing standard for the bedside care of babies with GS.

### 1.2. Care standardization

#### 1.2.1. NICU admission and intravenous therapy

All babies with GS had naso- or orogastric tubes placed, and were placed in sterile “bowel bags” up to the axillae, to ensure bowel protection. Historically, IV fluid administration had demonstrated significant practice variation in terms of type and volume of fluid used. We elected to standardize our fluids to 10% Dextrose in normal saline (D10NS), at 100 cm<sup>3</sup>/kg/h, with additional fluids given for clinically evident hypovolemia. Peripheral IVs (specifically avoiding the umbilical cord), were started, and a peripherally-inserted central catheter (PICC) was placed within 24 h of admission. Choice of antibiotic was guided by a literature review, which identified the organisms most commonly isolated in GS-associated SSIs, as well as input from specialists from pediatric infectious disease, microbiology and clinical pharmacy [15,16]. The umbilical stump becomes colonized with bacteria soon after delivery and the devitalized umbilical stump is an excellent media that supports bacterial growth, and provides direct access to the blood stream via umbilical vessels [17,18]. The intent of IV antibiotic therapy was to provide “prophylaxis” against infection during silo placement, as well as empiric therapy while the intestines were in a silo. We also identified a subset of babies judged to be at increased infectious risk: those at risk for or with features of Early Onset Sepsis (EOS) (prematurity, maternal Group B Strep carrier and/or clinical features of chorioamnionitis), and/or those with evidence of severe GS-associated bowel injury, as determined by a validated GS bowel injury measurement tool [19], which was recorded by the pediatric surgery fellow/attending directly into the orders. All patients were stratified into one of two antibiotic pathways: 1) patients with no concern for EOS and low risk GS bowel injury received IV cloxacillin and tobramycin/gentamicin as long as the silo was in situ; 2) patients with concerns for EOS and/or high risk GS bowel injury received ampicillin and tobramycin/gentamicin (immediately after blood cultures were obtained) and IV cloxacillin. Ampicillin, tobramycin/gentamicin and cloxacillin continued while the silo remained in situ, and the duration of ampicillin therapy was guided by the need to cover EOS. Both groups also received antibiotic prophylaxis for silo placement (first doses within 60 min prior to silo placement). Pre-printed physician orders, nursing procedures and point of care educational materials within pre-assembled GS admission packets

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