Gastrocutaneous fistulae in children - a systematic review and meta-analysis of epidemiology and treatment options

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Purpose: Gastrostomy tubes are a common adjunct to the care of vulnerable pediatric patients with several short and long-term risks. This study systematically evaluates the epidemiology and risk-factors for gastrocutaneous fistulae (GCF) in children, and reviews treatment options focusing on non-operative management (NOM).

Methods: After protocol registration (PROSPERO-CRD59565), multiple databases were searched. Studies describing epidemiology in children and GCF treatment at any age were included. Critical appraisal was performed (MINORS risk-of-bias assessment tool); one-sided meta-analysis was executed to estimate efficacy of therapeutic adjuncts using a random-effects model.

Results: Fifteen articles evaluating pediatric GCF were identified; 47% defined GCF as persistence >1 month which occurred in 32%±12% of cases. Risk factors for pediatric GCF include age at gastrostomy, timing of removal, open technique and fundoplication. Mean MINORS score was 55%±17%. Seventeen additional studies were identified reporting 134 patients undergoing NOM (endoscopic, systemic and local therapies); one pediatric comparative study was identified. Overall aggregate proportion of GCF closure after any NOM is 76% (63% success rate in local/systemic therapies 88% success rate in endoscopic approaches, see figure 1). No adverse events were reported.

Conclusion: Persistent GCF complicates the management of gastrostomies in 1/3rd of children with predictable risk factors. Several treatment options exist that obviate the need for general anesthesia; their efficacy is unclear. Further prospective investigations are clearly warranted.
Figure 1. Forest plot showing aggregate proportion of successful gastrocutaneous fistula closure using nonsurgical therapeutic options in pediatric and adult patients.

<table>
<thead>
<tr>
<th>Studies</th>
<th>Estimate (95% C.I.)</th>
<th>Ev/Trt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonzalez-Oreja, et al. 2004</td>
<td>0.938 (0.770, 1.000)</td>
<td>7/7</td>
</tr>
<tr>
<td>Hammed, et al. 2009</td>
<td>0.750 (0.551, 1.000)</td>
<td>3/3</td>
</tr>
<tr>
<td>Luijish, et al. 2010</td>
<td>0.750 (0.551, 1.000)</td>
<td>7/7</td>
</tr>
<tr>
<td>Thomas, et al. 2015</td>
<td>0.075 (0.045, 0.134)</td>
<td>5/6</td>
</tr>
<tr>
<td>Stringel, et al. 2013</td>
<td>0.075 (0.045, 0.134)</td>
<td>5/6</td>
</tr>
<tr>
<td>Overall (P&lt;0.001)</td>
<td>0.740 (0.627, 0.894)</td>
<td>91/134</td>
</tr>
</tbody>
</table>

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Synthetic scaffolding and amniotic fluid mesenchymal stem cells: a new surgical option for long gap esophageal atresia

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Purpose: Esophageal atresia occurs in 1 in 3000 births. Typically, surgical repair includes reconnection of the esophagus or in cases where the esophagus cannot be reconnected, interposition of a piece of stomach or intestine. These surgical options cause significant morbidity, therefore, a new therapeutic option is needed.

Methods: Porcine amniotic fluid stem cells were obtained via amniocentesis approximately 70-90 days prior to term. Cells were isolated, expanded and characterized via flow cytometry and qRT-PCR. Cells were over 90% positive for mesenchymal stem cell markers CD73, CD90 and CD105. Approximately 10 million cells were seeded onto the extra luminal surface of a polyurethane scaffold (Biostage™) and allowed to incubate for 7 days in a rotating hollow organ bioreactor (Biostage™). Approximately 4cm of intra-thoracic esophagus was removed in 2 piglets from the same litter as the isolated amniotic fluid stem cells and replaced with the seeded scaffolding in accordance with IACUC approval (HH#2014-0132). The lumen was stented open with a 10 mm biliary stent.

Results: The stent was removed and changed at 3 weeks, which revealed that the scaffold had been extruded and the lumen was regenerated. Piglets were fed via feeding tube for 5-6 weeks, and then successfully transitioned to oral feeding.

Conclusion: These piglets demonstrate the translational application of maternal amniotic fluid stem cells and a bioengineered synthetic scaffold in replacing missing gaps of esophageal tissue in offspring. Further studies are ongoing to delineate the mechanism of esophageal regeneration.

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National management guidelines for the care of infants with congenital diaphragmatic hernia

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Purpose: The move toward evidence-based healthcare is facilitated by the development of standardized best practices which optimize quality, consistency and cost-effectiveness of care. Based on its complexity, need for integrated multidisciplinary healthcare, and the demonstrated existence of practice and outcome variation, CDH represents an ideal target for the creation of Canadian management guidelines.

Methods: An interdisciplinary, geographically representative group of 17 Canadian clinician-researchers created AGREE-2 compliant recommendations informed by standardized literature reviews which targeted 19 questions addressing prenatal, in-hospital, and post-discharge phases of care. A modified Delphi process utilizing a pre-determined consensus framework led to the recommendations over a 2 day, in-person meeting.

Results: Forty-two recommendations encompassed the trajectory of CDH care: (a) Prenatal – risk stratification based on prenatal imaging (US and MRI); delivery plan and mode; (b) In-hospital – immediate resuscitation (intubation, fluids, inotropy, corticosteroids); ventilation strategies; timing of echocardiography; pulmonary hypertension management; role of ECLS; surgical “readiness” criteria; timing of CDH repair; method of surgical repair (open vs MIS); patch materials; surgery on ECLS; treatment of gastroesophageal reflux; and (c) Post-hospital discharge – details of long-term interdisciplinary follow-up. Professional society (CAPS, CPS, SOGC, CCCS, CNN) and Patient Advocacy (Rare Disease Foundation, Canadian Family Advisory Network) stakeholder engagement was obtained. An implementation strategy with a focus on guideline compliance as a measure of care quality is under development.

Conclusion: The guideline development methodology described proved effective and may be applicable to other rare, complex disease processes. Implementation of these guidelines should improve CDH outcome and hospital resource utilization.

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Oral Feeding Outcomes in Infants with Esophageal Atresia and Tracheoesophageal Fistula

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Purpose: To explore oral feeding outcomes in infants born with Type-C esophageal atresia and tracheoesophageal fistula (EATEF).

Methods: Retrospective cohort study of all infants undergoing surgery at our institution for Type-C EATEF born between 2005 and 2015.

Results: 49 infants were identified. 71% were exclusively orally feeding at discharge home. The balance were receiving combination oral/tube feeds (18%), exclusive tube feeds (8%), or combination oral/tube/parenteral nutrition (2%). Variables anticipated to predict oral feeding were explored. The presence of structural cardiac anomaly predicted exclusive oral feeding. Of the infants without cardiac anomaly, 79% were on exclusive oral feeding at discharge. However, only 46% of babies with cardiac anomaly had exclusive oral feeding, p = 0.055 (Fisher’s exact). Multivariate logistic regression analysis was completed with the most statistically non-significant variables removed, leaving structural cardiac anomaly and corrected gestational age at discharge as significant predictor variables.

Conclusion: Oral feeding is an important outcome for families and their children. We report the rate of oral feeding at discharge for infants with Type-C esophageal atresia/tracheoesophageal fistula, and identified structural cardiac anomaly and corrected gestational age at discharge as predictor variables. This is important for health care professionals and the families of children born with esophageal atresia/tracheoesophageal fistula and cardiac abnormalities, as the majority go home with supplemental nutrition by gavage tube or other routes.

<table>
<thead>
<tr>
<th>Variable</th>
<th>p-value</th>
<th>Odds ratio</th>
<th>Lower limit</th>
<th>Upper limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected gestational age at discharge home (weeks)</td>
<td>0.02</td>
<td>0.699</td>
<td>0.513</td>
<td>0.952*</td>
</tr>
<tr>
<td>Birth weight</td>
<td>0.27</td>
<td>1.320</td>
<td>0.805</td>
<td>2.165</td>
</tr>
<tr>
<td>Structural cardiac anomaly</td>
<td>0.04</td>
<td>0.222</td>
<td>0.054</td>
<td>0.919*</td>
</tr>
<tr>
<td>Postoperative esophagram finding</td>
<td>0.41</td>
<td>1.692</td>
<td>0.484</td>
<td>5.919</td>
</tr>
<tr>
<td>Early transanastomatic feeding</td>
<td>0.14</td>
<td>5.200</td>
<td>0.598</td>
<td>45.186</td>
</tr>
<tr>
<td>Tracheomalacia</td>
<td>0.06</td>
<td>0.232</td>
<td>0.051</td>
<td>1.051</td>
</tr>
<tr>
<td>Gastroesophageal reflux at time of discharge</td>
<td>0.09</td>
<td>0.289</td>
<td>0.069</td>
<td>1.217</td>
</tr>
</tbody>
</table>

* statistically significant (p<0.05)

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Congenital tracheo-esophageal fistula repair in Ontario over the last 20 years: volume and outcomes

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Purpose: This study was designed determine the volume, post-operative surgical outcomes and if possible the relationship between outcome and institutional / surgeon volume in neonates undergoing tracheo-esophageal fistula (TEF) repair over the last 20 years in Ontario.

Methods: Using administrative databases a population based cohort study of patients undergoing TEF repair at 4 paediatric centres in Ontario between 1993 and 2012 was conducted. Patient demographics, primary and secondary outcomes were analyzed using standard statistical methods.

Results: 465 patients with the diagnosis of TEF met inclusion criteria. The mean number of TEF repairs per year per was 5.8, there was a significant difference in hospital annual volume between institutions (range 12.3-3.35: p<0.05). The average number of cases/ surgeon for the last 10 study years ranged between 0.5 and 2 cases/ year. Primary outcome: repair of recurrent fistula or intestinal interposition was 5.3%, with no reportable difference between institutions. Secondary Outcomes: 45.6% underwent dilatation for esophageal strictures following TEF repair and 19.8 % underwent some type of drainage procedure of the chest; the rate of these interventions was not significantly different between institutions. A significant difference was found between institutions in the rate of gastrostomy (15.2-37.8%) tube insertion. The overall rate of fundoplication was 11%.

Conclusion: This study highlights the difficulty in determining surgeon or institution volume outcome relationships following TEF repair, as both primary and secondary outcome event rates are very low. This study provides insight into the outcomes following TEF repair in Ontario and the need to study the surgical/ clinical care pathways.

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Amniotic fluid stem cell exosomes rescue fetal lung development in experimental congenital diaphragmatic hernia

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Purpose: To investigate the ability of amniotic fluid stem cell (AFSC) exosomes to rescue fetal lung development in a model of congenital diaphragmatic hernia (CDH) and pulmonary hypoplasia (PH).

Methods: Exosomes were isolated from AFSC conditioned medium via ultra-centrifugation. To reproduce CDH/PH, nitrofen was administrated to dams at E9.5, and lungs were harvested from fetuses at E14.5 and used to derive EpCAM+ primary epithelial cells (in vitro) or for explants (ex vivo). Lungs from untreated dams served as control. In vitro: proliferation (5-ethynyl-2′-deoxyuridine staining) and apoptosis (live/dead assay) rates were compared between control and cells cultured with epithelial medium alone, AFSC-exosomes or AFSC-exosome-free medium. Ex vivo: Expression levels of lung development markers (surfactant protein-C, fibroblast growth factor-10, thyroid transcript factor-1, vascular endothelial growth factor-a) were measured (RT-qPCR) on control explants and lungs cultured with epithelial medium alone or AFSC-exosomes. Statistics: One-way ANOVA (Tukey post-test).

Results: In vitro: Nitrofen significantly reduced cell proliferation and increased apoptosis. This detrimental effect was rescued by AFSC-exosomes (similar levels to control), but not by AFSC-exosome-free medium (Fig.1A, B). Ex vivo: AFSC-exosome treated explants had similar levels of lung development markers as control lungs (Fig.1C).

Conclusion: AFSC-exosomes have a beneficial effect on lung development in experimental CDH. AFSC-exosomes could represent a promising cell-free therapy in babies with CDH and pulmonary hypoplasia.
Fig. 1

A

% Proliferation

Control
Epithelial Medium
AFSC-exosomes
AFSC-exo-free media

B

% Dead cells

Control
Epithelial Medium
AFSC-exosomes
AFSC-exo-free media

C

Relative Normalized Expression

Target Genes

Control
Epithelial Medium
AFSC-exosomes

SftC
Ttf1
Fgf10
VegfA

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Prenatal prognostic markers correlate with pulmonary hypertension severity in congenital diaphragmatic hernia neonates

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Purpose: Prenatal observed/expected lung-head ratio (O/E LHR) by ultrasound correlates with postnatal mortality for congenital diaphragmatic hernia (CDH) patients. The aim of this study is to determine if O/E LHR correlates with pulmonary hypertension (PH) outcomes for CDH patients.

Methods: A single centre retrospective chart review was performed for CDH neonates from January 1, 2006 to December 31, 2015 (REB #1000053124). Prenatal O/E LHR, hernia side and liver position were recorded. Postnatal data included echocardiogram (ECHO) and lung perfusion scan (LPS) results up to 5 years of age.

Results: Of 154 CDH newborns, 123 survived (80.6%) and 42 (27.5%) had both O/E LHR measurements and postnatal ECHO results up to 5 years of age. “High risk” neonates (O/E LHR ≤50%) had high right-sided ventricular pressures (RVsp) initially but almost all had progressive resolution of PH by age 5 years (p<0.05, Table 1). However, serial LPS scans showed no significant change in lung perfusion over time (p>0.05), regardless of initial PH severity, suggesting PH resolution did not depend on increased ipsilateral lung perfusion to offload the right ventricle.

Conclusion: Prenatal prognostic markers correlated with initial pulmonary hypertension severity for CDH newborns, with resolution over time despite fixed perfusion bias to the lungs. These results suggest favorable pulmonary hypertension outcomes for CDH patients who survive beyond infancy.
<table>
<thead>
<tr>
<th>Mortality Risk*</th>
<th>Age</th>
<th>Mean RVsp (mmHg)</th>
<th>Median RVsp (mmHg)</th>
<th>RVsp Range (mmHg)</th>
<th>Mean LPS Diff (%)</th>
<th>Median LPS Diff (%)</th>
<th>LPS Diff Range (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Birth*</td>
<td>56.93 (n=15)</td>
<td>60</td>
<td>30-83</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td>51.25 (n=8)</td>
<td>43</td>
<td>35-85</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>High</td>
<td>Discharge*</td>
<td>49.7 (n=18)</td>
<td>45</td>
<td>18-98</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td>41.75 (n=8)</td>
<td>34.5</td>
<td>24-71</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>High</td>
<td>6m-1yr**</td>
<td>29.75a (n=8)</td>
<td>32.5</td>
<td>22-38</td>
<td>40.13g (n=15)</td>
<td>44</td>
<td>10-66</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td>23.6b (n=5)</td>
<td>24</td>
<td>20-28</td>
<td>36.22g (n=9)</td>
<td>38</td>
<td>28-44</td>
</tr>
<tr>
<td>High</td>
<td>2-5yrs**</td>
<td>28.17 (n=6)</td>
<td>26</td>
<td>17-44</td>
<td>31.6g (n=10)</td>
<td>30</td>
<td>10-50</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td>24.2 (n=5)</td>
<td>24</td>
<td>14-37</td>
<td>30gb (n=8)</td>
<td>30</td>
<td>24-36</td>
</tr>
</tbody>
</table>

Table 1. RVsp and lung perfusion differential of CDH patients compared to mortality risk by O/E LHR

*high indicates O/E LHR<50%, low indicates O/E LHR>50%

a,b p < 0.05 by Independent T-test

*** p < 0.05 by Pearson Correlation test for mean RVsp

# p > 0.05 by Independent T-test and Pearson Correlation test

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Growth and neurodevelopmental outcomes of infants with esophageal atresia and tracheoesophageal fistula

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Purpose: Esophageal atresia/tracheoesophageal fistula (EA/TEF) is a complex disorder, and most outcome data on these children is confined to mortality and feeding-related morbidities. Our objective was to examine mortality and growth and neurodevelopmental outcomes in a large recent cohort of infants with EA/TEF.

Methods: Following IRB approval, all infants with EA/TEF referred to the NICU from Jan 2000 to Dec 2015 were identified. Data on associated defects, neonatal morbidity and mortality and growth and developmental outcomes at 12-36 months was collected. Data was analysed using descriptive statistics. Multiple regression analysis was carried out to determine the variables associated with mortality or adverse outcome.

Results: 253 infants were identified. Mean birth weight was 2745g (range 540-4390) and GA 36.7 weeks (range 23-41). 102 infants (40%) were preterm. There were 20 (7.9%) deaths, 17 of these had major cardiac malformations. 182 (78%) children had neuro-developmental assessments during the first 36 months. Neurodevelopmental delay was found in 23%, most often in speech, and was severe in 3. Two had cerebral palsy. Nine (5%) infants had hearing impairment, and 4 (2%) visual impairment. Considering feeding problems, 47 (26%) required G-tube insertion and 49 (19%) had weight growth velocities less than the 10th centile. Many community interventions were provided, Speech/Language Therapy was the most common.

Conclusion: Mortality in EA/TEF is mainly related to the associated anomalies, particularly cardiac defects, p<0.001. Close follow up for these infants is important for early identification and intervention for growth failure or developmental delay.

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Decision-making criteria for observational management of congenital pulmonary adenomatoid malformations (CPAMs)

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Purpose: To determine practice patterns of Canadian surgeons managing congenital pulmonary adenomatoid malformations (CPAMs) and factors influencing practice.

Methods: Practicing pediatric surgeons in Canada were surveyed regarding their training, experience, evaluation, management and follow up of CPAMs and what factors qualified patients for observation vs resection. Data were summarized and Fisher’s Exact and Kruskal-Wallis Tests applied where appropriate.

Results: 60%(n=41) of surgeons responded. The median age of recommended initial assessment by a pediatric surgeon was one month, with 17% evaluating in hospital. 97%(40/41) use CXR for initial imaging. 85%(35/41) recommended a CT scan for further evaluation, 43% by 3 months and 43% between 3-6 months. Observational management was offered always, almost always or sometimes by 2.4%, 31.4% and 39%, respectively while only 14.6% almost never and 9.7% never offered it. Number of years in practice and country of training were not found to be associated with this decision (p=0.41 & 0.95, respectively). Of surgeons who offer observational management (n=37), 76%(28/37) use morphology (cyst size, solid components, multi-lobar) to guide their decision. Similarly, 57%(21/37) use the size of the lesion but this varied between <1cm and <5cms. 62%(23/37) consider the number of lesions and 61%(14/23) of those only offered observation to solitary lesions.

Conclusion: Most practicing pediatric surgeons in Canada offer observational management to some patients with asymptomatic CPAMS. While practice variations exist, detailed imaging with a CT scan early and life to determine the morphology, size and number of lesions guides practice. Regular follow up with a pediatric surgeon is recommended.

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The effects of health system factors on all-cause morbidity and costs after pediatric appendectomy: a national cohort study

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Purpose: Appendicitis is the most common surgical emergency in children. The primary aim of this study was to determine health system factors affecting all-cause morbidity after appendectomy in national cohort of pediatric patients. The secondary aim was to examine the effect of these factors on costs.

Methods: Patients aged 17 or younger who underwent appendectomy in Canada (excluding Quebec) between April 2008 and March 2015 were included. Morbidity during index admission was defined as a complication resulting in more than 24 hours increased length of stay. Cost represented the cost of the index admission. Multi-level linear regression logistic and linear regression was used to model complications and costs, respectively.

Results: We identified 41,512 patients, and the morbidity rate was 6.4%. After adjustment, laparoscopy (0.83, 95%CI 0.74-0.93 p=0.001), increasing age (0.98, 95%CI 0.97-0.99 p<0.001), and surgeon volume (0.85,95%CI 0.77-0.94 p=0.001) significantly decreased risk of morbidity. Pediatric surgery specialists and pediatric hospitals conferred no effect. Average inpatient cost was $4,715 (SD ± $2,981). Pediatric hospitals ($755 95%CI $253-$1,274 p<0.001) were associated with cost increase. Modest costs decreases were seen for laparoscopy ($-273 95%CI $-336 - $-211p<0.001) and age ($-10/year 95%CI $-17 - $-3 p<0.001).

Conclusion: We conclude that in a national study of Canadian children undergoing appendectomy, laparoscopy, surgeon volume and increasing age are the most important factors in decreased morbidity. Laparoscopy and increasing age were associated with decreased cost. Pediatric surgical specialty was not associated with a change in cost or morbidity.

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Nonoperative treatment for acute appendicitis: long-term outcomes

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Purpose: Nonoperative treatment for acute appendicitis is now an accepted approach; there are few reports in children. The aim of this study was to show long-term outcomes of the nonoperative treatment in children.

Methods: Between April 2012 and December 2016, all acute appendicitis patients were asked to select either operative (Classique surgery) or nonoperative treatment on admission. For nonoperative treatment, intravenous injection of antibiotics was continued until serum C-reactive protein concentration decreased to below 0.5 mg/dL. A questionnaire survey on satisfaction with treatment was added afterwards and performed more than 1 year after treatment.

Results: 94 patients chose nonoperative treatment. The success rate of nonoperative treatment was 95.5%. There was no difference in the length of hospital stay between the two groups. Ileus occurred in two operatively-treated patients, while recurrence of appendicitis occurred in 22 nonoperatively-treated patients (28.6 %) after an average of 4.3 years of follow-up.

Conclusion: the success rate of nonoperative treatment was very high, a considerable number of patients experienced recurrence.

Sponsoring CAPS member: Global Paediatric Surgery Group

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Safety and feasibility of same-day discharge for uncomplicated appendicitis: a prospective cohort study

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Purpose: Appendicitis is the most common gastrointestinal pediatric surgical emergency. With the introduction of laparoscopic techniques in the early 1980s, the recovery time, level of pain and hospital stay of patients undergoing laparoscopic procedures has been significantly reduced. While many laparoscopic procedures such as cholecystectomy and incisional hernia repair are performed as outpatient surgeries, pediatric appendectomy patients continue to be hospitalized for post-operative observation. Our goal was to evaluate the safety and feasibility of same day discharge after laparoscopic appendectomy for uncomplicated appendicitis at our institution.

Methods: After IRB approval, all otherwise healthy pediatric patients ages 2 to 18, undergoing laparoscopic appendectomy during 2016 for non-complicated appendicitis were eligible for the study. Decision for same day discharge was based on surgeon preference and parental agreement. Data regarding demographics, admission and discharge times and outcomes of complications (surgical site infection, abscess, nausea and/or vomiting, intractable pain), readmissions, return to the emergency department and non-scheduled clinic visits were collected.

Results: A total of 1321 appendectomies were performed during the study period; 961 were uncomplicated, of which 382 (40%) were discharged the same day, either from PACU or the floor. There were 2 readmissions (one for pain, one intraabdominal abscess), 4 superficial surgical site infections, 10 patients with nausea or vomiting and 33 patients with pain control issues, 9 of whom presented to the ED.

Conclusion: Same day discharge for laparoscopic non-complicated appendectomy is a safe and feasible alternative to post-operative admission and observation. This has the potential to yield significant health care cost savings.

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The role of glucagon like peptide-2 in regulating intestinal adaptation following intestinal resection or repair of gastroschisis in infants

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Purpose: The enteric hormone glucagon-like peptide 2 (GLP-2) has been implicated as regulating intestinal function but the effects in infants are unclear. This study investigated the relationship between GLP-2 production, GLP-2 sensitivity and intestinal adaptation in infants following resection or repair of gastroschisis.

Methods: With IRB approval (U Calgary #10656) parental consent of infants undergoing surgery for monitoring of nutritional status, GLP-2 levels, and tissue sampling. Controls were inpatients admitted for non-intestinal illness.

Results: 68 infants underwent 3 or more assessments of GLP-2 responses after surgery, 12 controls underwent testing. Infants weaned from parenteral nutrition (PN) had increased GLP-2 (86±32 n= 24 vs controls:45±20 n=10 vs prolonged PN:42±6 pM, n=10). This was maintained out to one year. (Data: mean±SD, p<0.05 via ANOVA). GLP-2 levels and time to wean from PN correlated with the length of remnant small intestine. Infants with gastroschisis (n=33) had decreased GLP-2 levels until enteral function was achieved and then became elevated: (21±15 with first feeding vs 102±60 at full feeds and 60±19 pM at one year). There were no changes in the density or distribution of GLP-2 producing L-cells nor the GLP-2 receptor with gestational age or post resection. There was an increase in both L-cell density and receptor expression in infants with gastroschisis.

Conclusion: GLP-2 production correlates with intestinal adaptation in infants. GLP-2 productive capacity (L-cell expression) and GLP-2 receptor expression do not vary with maturity or after surgery. The findings support a role for GLP-2 in regulating intestinal function in infants; further study is needed.

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Hospital level and case-load of pediatric appendectomies correlates with risk for complications after appendectomy in children – a population-based study

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Purpose: To investigate the impact of hospital administrative level and operative volume of pediatric appendectomies on surgical morbidity and mortality.

Methods: The Swedish National Patient Register was queried for all children 0-14 years with acute appendicitis or appendectomy from 1987 to 2009. Exposure was defined as hospital administrative level, defined as pediatric surgery centre, central general hospital, or general hospital, and the hospital’s annual case-load of pediatric appendectomies. Outcomes were length of postoperative hospital stay, re-operations or re-admissions within 30 days and mortality within 90 days. For comparative analyses, a multivariable regression model was created, adjusting for available confounders. The study was approved by the Regional Ethics Review Board.

Results: 55,591 patients were identified. Mortality was low (n=7). The risk of re-operations was higher in general hospitals and central general hospitals compared to pediatric surgery centres (p<0.01) and in low volume hospitals (p<0.01) in non-perforated appendicitis in children 5-14 yrs. Re-admissions were more common in general hospitals and central general hospitals after non-perforated appendicitis in all age groups (p<0.05), in perforated appendicitis in children 0-4 and 10-14 yrs (p<0.05), and for overall appendicitis in low volume hospitals (p<0.001). The postoperative length of stay was shorter in central general hospitals and general hospitals and in low-volume centres, than in pediatric surgery centres (p<0.05).

Conclusion: We conclude that specialized pediatric surgical care reduced the risk of postoperative complications, including reoperations and readmissions, compared to care at central general hospitals and general hospitals for pediatric appendicitis.

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The management of perforated appendicitis: a tale of two centres

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Purpose: Significant variations exist in the care of children with perforated appendicitis. We conducted a comparison of outcomes between two Canadian centres with different treatment approaches.

Methods: Children treated for perforated appendicitis during a 14-month period (May 2015-July 2016) at two Canadian pediatric surgical centres were compared. Non-operative management was used selectively in Centre 1, and rarely in Centre 2. A strict treatment protocol was used in Centre 2, but not Centre 1. Analyzed outcomes included length of hospital stay, incidence of post-operative infectious complications, number of invasive procedures, and readmission rates.

Results: Centres 1 and 2 treated 47 and 92 patients, respectively during the study period. Data regarding patient characteristics, diagnostic modalities, interventions, and outcomes are shown in the table. Non-operative management was used only in Centre 1 during the study period. A higher frequency of initial non-operative management in Centre 1 was associated with increased use of diagnostic imaging at presentation, significantly more invasive procedures, and a higher readmission rate. Total hospital stay (including readmissions) and post-operative infectious complications did not differ between the centres.

Conclusion: Increased utilization of initial non-operative management in children with perforated appendicitis requires more diagnostic imaging and is associated with an increased readmission rate and likelihood of multiple invasive procedures.

<table>
<thead>
<tr>
<th></th>
<th>Centre 1</th>
<th>Centre 2</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>47</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>Median Age (years)</td>
<td>11.0</td>
<td>9.9</td>
<td>.12</td>
</tr>
<tr>
<td>Median Symptom Duration (days)</td>
<td>2</td>
<td>3</td>
<td>.06</td>
</tr>
<tr>
<td>Median WBC Count (1000/ul)</td>
<td>15.9</td>
<td>16.7</td>
<td>.79</td>
</tr>
<tr>
<td>% With Well Formed Abscess</td>
<td>40</td>
<td>70</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Diagnostic Imaging</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Receiving Ultrasound @ presentation</td>
<td>92</td>
<td>62</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>% Receiving CT Scan @ presentation</td>
<td>13</td>
<td>5</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Non-Operative Management (%)</td>
<td>19</td>
<td>0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Laparoscopic Appendectomy (%)</td>
<td>95</td>
<td>97</td>
<td>.63</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median Length of Total Hospital Stay (days)</td>
<td>4</td>
<td>5</td>
<td>.43</td>
</tr>
<tr>
<td>Superficial Surgical Site Infections (%)</td>
<td>6</td>
<td>4</td>
<td>.69</td>
</tr>
<tr>
<td>Deep Surgical Site Infections (%)</td>
<td>11</td>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>% Undergoing &gt; 1 Invasive Procedure</td>
<td>23</td>
<td>4</td>
<td>.005</td>
</tr>
<tr>
<td>Readmissions (%)</td>
<td>26</td>
<td>2</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
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Factors influencing caregiver choice of medical versus surgical treatment of appendicitis

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Purpose: To examine what proportion of caregivers, if given a choice, would choose medical versus surgical treatment of appendicitis and what factors would be important in their decision.

Methods: A survey was given to the caregivers of children presenting to the pediatrician for a routine visit. Participants were asked to choose between medical or surgical treatment if their child were to develop appendicitis. They were asked to rate the importance of certain factors in their decision. Surveys were distributed in community and academic pediatric clinics. This study was approved by the Institutional Review Board (IRB). Statistical analyses were performed using Statistical Analysis Software (SAS).

Results: 400 surveys were distributed with a 96% response rate. 5.5% of respondents reported a history of appendicitis and 82.0% were mothers. 57.9% (95% CI: [52.6, 63%]) of respondents chose surgery over medical treatment of appendicitis. Fathers chose surgery at the same rate as mothers. Level of education and history of appendectomy were not different between the two groups. There were no differences between groups when considering the importance of pain and cost. Caregivers who chose medical treatment placed more importance on time in hospital (p=.002) and time out of school (p=.03). Those who chose surgery placed more importance on risk of recurrent appendicitis, (p<.001).

Conclusion: 42.1% of caregivers would choose non-operative therapy for their children with acute appendicitis. The risk of recurrence, time in hospital, and time out of school are significant factors that families may consider when making a decision regarding the treatment of appendicitis.

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Standardized reporting of appendicitis-related findings improves reliability of ultrasound in diagnosing appendicitis in children

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Purpose: Our objective was to increase ultrasound reliability for diagnosing appendicitis in an academic children’s hospital emergency department (ED) through a multidisciplinary quality improvement initiative.

Methods: A retrospective review of ultrasound use in patients diagnosed with appendicitis in our ED from 1/1/2011 – 6/30/2014 established a baseline cohort. From 8/1/2014 – 7/31/2015 a diagnostic algorithm that prioritized ultrasound over CT was used in our ED and a standardized template was implemented for the reporting of appendicitis-related ultrasound findings by our radiologists. During the prospective observational period, all ED patients with suspected appendicitis were prospectively followed, and any discharged from the ED received a follow-up phone call.

Results: Of 627 patients diagnosed with appendicitis in the ED during the retrospective review, 46% (n=289) had an ultrasound. After implementation of the diagnostic algorithm and standardized ultrasound report 75% (n=627) of 840 patients with suspected appendicitis and 79% (n=211) of 267 patients diagnosed with appendicitis had an ultrasound (p<0.0001). After implementation of the standardized ultrasound report the frequency of indeterminate results decreased from 44% to 13% and positive results increased from 46% to 66% in patients with appendicitis (p<0.0001). The sensitivity of ultrasound (indeterminate counted as negative) increased from 51% to 69% (p<0.0001). The diagnostic algorithm had a sensitivity of 99% and specificity of 94%.

Conclusion: Ultrasound reliability for the diagnosis of appendicitis in children can be improved through standardized results reporting; however, these changes should be made as part of a multidisciplinary quality improvement initiative to account for the initial learning curve necessary to increase experience.
Intrathyroidal thymus tissue in children: avoiding unnecessary surgery

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\textsuperscript{2}Department of Pediatric Diagnostic Radiology, Montreal Children’s Hospital, McGill University, Montreal, Québec, Canada

Purpose: Intrathyroidal thymic tissue may be misinterpreted as a malignant thyroid lesion. Given the higher risk of thyroid malignancy in children, this may prompt invasive investigations or surgery. The aim of this study was to describe the imaging features and management of these lesions and evaluate the safety of non-operative management.

Methods: With REB approval, we performed a retrospective review of all patients <18 years with intrathyroidal thymic tissue at a tertiary care academic center from 2000 to 2016. Data collection included patient demographics as well as clinico-radiologic findings of ectopic thymic tissue. Detailed ultrasound results were compared with features identified in the literature and presented as mean (standard deviation).

Results: Ten patients were identified over the study period. The mean patient age and lesion size (+/- SD) was 5 years (2.1) and 2.1cm (2.9). Five lesions were identified as an incidental finding; 6/10 were left-sided and the most common site was lower pole. Ultrasonographic features in our cohort were consistent with previous descriptions: well demarcated (9/10) hypoechogenic lesions (10/10) containing punctate/linear hyperechogenicities (10/10) and occasional mild hypervascularity (6/10). All cases demonstrated interval stability in both size and echotexture over a mean follow-up time of 3.1 years (1.9). None required surgical excision; one patient underwent fine needle aspiration for atypical features.

Conclusion: Intrathyroidal thymic tissue has characteristic clinical and ultrasonographic findings in children. Clinicians should consider these lesions when interpreting pediatric head-and-neck ultrasonography as these may be safely observed.

\begin{table}
\centering
\caption{Ultrasound features of patients with intrathyroidal thymus tissue}
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Patient & Location & Echogenicity & Vascularity & Linear / Punctate hyperechogenicities & Demarcation \\
\hline
1 & Rt-mid & "resembles thymus" & yes mild & punctate & well demarcated, no capsule \\
2 & Lt-mid & hypoechoic & no & punctate & well-demarcated no capsule \\
3 & Lt-posterior & "resembles thymus" & no & punctate & well demarcated, no capsule \\
4 & Rt-upper & hypoechoic & no & punctate & well demarcated, no capsule \\
5 & Rt & hypoechoic & no & punctate & well demarcated, no capsule \\
6 & Lt-infereior & hypoechoic & yes mild & punctate & well demarcated, no capsule \\
7 & Rt-lower & hypoechoic & yes mild & punctate & ill defined \\
8 & Lt-lower & hypoechoic & yes mild & punctate & well-demarcated \\
9 & Lt-mid & "resembles thymus" & yes mild & punctate and linear & well demarcated, no capsule \\
10 & Lt-lower & "resembles thymus" & yes mild & punctate & well-demarcated no capsule \\
\hline
\end{tabular}
\end{table}
### Table 2 – Outcomes of patients with intrathyroidal thymus tissue

<table>
<thead>
<tr>
<th>Patient</th>
<th>Management Strategy</th>
<th>Follow-up Period (years)</th>
<th>Clinical Status</th>
<th>USFNA</th>
<th>Surgical Resection</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Observation</td>
<td>2</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>Observation</td>
<td>2</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>Observation</td>
<td>1</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>Observation</td>
<td>2</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>Observation</td>
<td>3</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
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<tr>
<td>6</td>
<td>Observation</td>
<td>4</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>7</td>
<td>Observation</td>
<td>4</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
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<tr>
<td>8</td>
<td>Observation</td>
<td>2</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>9</td>
<td>Observation</td>
<td>8</td>
<td>Stable</td>
<td>No</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>10</td>
<td>Additional investigations</td>
<td>3</td>
<td>Stable</td>
<td>Yes</td>
<td>No</td>
<td>None</td>
</tr>
</tbody>
</table>

### Table 3 – List of case reports of intrathyroidal thymic tissue in children

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Sex/Age</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Segni [22]</td>
<td>11-year-old boy</td>
<td>U/S</td>
</tr>
<tr>
<td>2007</td>
<td>Megremis [23]</td>
<td>11-year-old boy</td>
<td>U/S, MRI</td>
</tr>
<tr>
<td>2008</td>
<td>Lignitz [3]</td>
<td>6-year-old boy</td>
<td>Hemithyroidectomy</td>
</tr>
<tr>
<td>2008</td>
<td>Hernandez-Cassis [5]</td>
<td>6-year-old boy</td>
<td>Surgical excision</td>
</tr>
<tr>
<td>2009</td>
<td>Aguayo-Figueroa [24]</td>
<td>4-year-old girl, 8-</td>
<td>Follow-up only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>year-old boy</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Durmaz [4]</td>
<td>4-year-old boy</td>
<td>FNA, Hemithyroidectomy</td>
</tr>
<tr>
<td>2012</td>
<td>Patel [25]</td>
<td>4-year-old girl</td>
<td>U/S</td>
</tr>
<tr>
<td>2014</td>
<td>Park [26]</td>
<td>4-year-old boy</td>
<td>FNA</td>
</tr>
</tbody>
</table>

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Dynamic bracing of pectus carinatum: a quantitative analysis

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Purpose: Pectus carinatum (PC) presents as an overgrowth of the costal cartilages resulting in a protrusion of the sternum. Primary treatment of PC is performed with an external brace that compresses the protrusion. Patients are 'prescribed' a brace tightening force; however, no visual guides exist to display this force magnitude. The purpose of this study was to determine the repeatability of patients in applying their prescribed force over time, and to determine whether the protrusion stiffness influences the participant-applied forces and the protrusion correction rate.

Methods: Eleven male participants were recruited (n=11, 10–18 years) at the time of brace fitting (Braceworks, Calgary, Canada) who met the inclusion criteria of symmetrical PC and no connective tissue disorders. Participants were evaluated on three visits: fitting, one month post-fitting, and two months post-fitting. Differences between prescribed force and participant-applied force were evaluated with a paired t-test. Relationships of participant-applied force and correction rate with protrusion stiffness were assessed with a general linear mixed model (α=0.05). Research ethics approval was obtained (University of Calgary REB14-1759).

Results: Majority of cases (72%) had a significantly different applied force (p≤0.05) from their prescribed force (1.94±0.68 lbs). Protrusion stiffness had no relationship with participant-applied force (p=0.11) or correction rate (p=0.37).

Conclusion: Participants did not follow their prescribed force. Magnitudes of these differences require further investigation to determine clinical significance. Participant forces and correction rate were not influenced by protrusion stiffness. Additional participants are required for statistical power. Other factors may influence these variables such as patient compliance, and require further study.

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Replacing gastrostomy tubes with collapsible bumpers in pediatric patients: is it safe to “cut” the tube and allow the bumper to pass enterally?

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Purpose: The “cut and push” technique for removal of gastrostomy tubes with collapsible bumpers offer an alternative to the standard traction method of removal. This study compares the outcomes of the cut and push and the traction techniques.

Methods: An institutional review board approved retrospective cohort study was completed, identifying all pediatric patients who underwent G-tube removal at a single center between December 2013 and December 2016. Outcomes included need for sedation and complications. Groups were compared using chi-squared and independent t-tests.

Results: We identified 127 children aged 3 months to 17 years (mean 4.1 years) who had gastrostomy tubes removed (94 cut and push = 74%). These groups were similar in terms of age, gender, weight, prior abdominal surgery, and time from insertion to removal. Significantly fewer children required sedation with the cut and push group (1.1% vs. 60.6%, p<0.001). Ten complications occurred, 9 in the cut and push group (9.6% vs. 3%, p=0.225), (OR 3.43, 95% CI 0.41-28.8, p=0.227). Mean age at time of complication was significantly less in the cut and push group (26 months vs. 75 months, p=0.004).

Conclusion: The cut and push technique for removing gastrostomy tubes with collapsible bumpers significantly reduce the need for procedural sedation, however it may be associated with increased risk of complications. While this data does suggest that the technique may be safe in older children, caution should be taken in younger children given the suggestion of increased risk of failure of the bumper to traverse the pylorus.

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Feasibility and safety of percutaneous endoscopic gastrostomy insertion in infants under 5 kg: a retrospective chart review

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Purpose: Percutaneous endoscopic gastrostomies (PEG) enable enteral nutrition for patients with inadequate oral intake. Laparoscopic and radiologic guidance have been applied in specific high-risk populations, including infants less than 5kg, with the intent of avoiding PEG-related complications. This cohort study shares our experience with PEG tube insertion in infants less than 5kg.

Methods: All patients under 5kg who underwent PEG insertion were included. Factors such as PEG-related complications within 16 weeks of insertion, gestational age, and insertion technique were collected. Demographics were analyzed using descriptive statistics, and reported as mean ± standard deviation.

Results: A total of 480 pediatric patients who underwent gastrostomy insertion between January 1, 2009 and February 1, 2017 were screened, and 128 were eligible. Mean weight at PEG insertion was 3705±872.63 grams, and mean gestational age was 35.75±4.75 weeks. Of the 128 patients, 60 (46.9%) were male and 68 (53.1%) were female. Superficial surgical site infection occurred in 3 (2.34%) patients. One (0.78%) of these patients required re-admission for antibiotic treatment and monitoring. No deep-space surgical site infections occurred. No procedure-related hemorrhage requiring readmission or transfusion occurred. No intra-abdominal injury or tube dislodgement requiring re-operation occurred. No procedure-related mortality occurred.

Conclusion: We conclude that the insertion of PEG tubes in infants under 5kg via traditional PEG method is safe and feasible. The use of resource-intensive techniques involving laparoscopic or radiographic guidance garners no significant benefits beyond PEG alone, and may not be warranted.

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The outcomes of fundoplication in neurologically impaired children at a tertiary healthcare center

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Purpose: To evaluate the outcomes of fundoplication and gastrostomy tube in neurologically impaired children.

Methods: A retrospective cross-sectional study was performed by reviewing the medical records of 178 neurologically impaired children who underwent fundoplication between 1999 and 2014 at a tertiary healthcare center. The data was analyzed by Statistical Package for Social Science, version 24. Any p-value <0.05 was considered significant.

Results: Of the 178 neurologically impaired children included in the study with a mean follow-up of 44 months, (61%) were male. Early post-operative complications of (61%) were gastrostomy site problems. Late complications (5%) included adhesive bowel obstruction and redo fundoplication for wrap failure. After fundoplication, the incidence rate (person-month) of all hospital admissions (0.95 vs. 0.13; p<0.001), gastroesophageal reflux-related admissions (0.67 vs. 0.09; p<0.001), and admissions for seizures (0.21 vs. 0.01; p<0.001) decreased significantly. Furthermore, all emergency department visits (0.94 vs. 0.23; p<0.001), gastroesophageal reflux–related visits (0.61 vs. 0.12; p<0.001), seizure-related visits (0.24 vs. 0.01; p<0.001) decreased remarkably. The overall mortality rate during the study period was (35%), nearly all of them are not surgical mortality. The predictors of mortality were being male (odds ratio: 2.2; p=0.027) and no code status (odds ratio: 5.2; p<0.001).

Conclusion: Fundoplication and gastrostomy insertion is effective in reducing hospital admissions and emergency department visits related to gastroesophageal reflux and seizures. Most of the early postoperative complications are gastrostomy site related and not from fundoplication. Although survival rate did not improve significantly, fundoplication had a notable effect on the quality of life.

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Epithelial cell marker cadherin-26 expression is lower in nitrofen-induced abnormal lung development in congenital diaphragmatic hernia

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Purpose: We have previously shown that nitrofen-induced congenital diaphragmatic hernia (CDH) lungs have a disturbed mesenchymal/epithelial cell balance and less distal airway branching. This might be the result of lower microRNA miR-200b expression around the large airways. We recently found that cadherin-26 was down-regulated in the lungs of our microRNA miR-200b knockout mice. Cadherins are critical for the organization of the airway epithelium, thereby facilitating cell-cell adhesion, cellular polarization, and proliferation. Cadherin-26 is abundantly expressed in airway epithelial cells. We aimed to determine the expression of cadherin-26 during nitrofen-induced abnormal lung development and CDH.

Methods: We induced abnormal lung development and CDH by gavaging nitrofen to dams on embryonic day (E) 9. We collected control and nitrofen-induced hypoplastic lungs at E13, E15, E18 and E21. Lungs were processed and Cadherin-26 expression was determined using immunohistochemistry and Western blotting.

Results: We observed lower cadherin-26 expression during the later stages of nitrofen-induced abnormal lung development when compared to control. Expression was particularly decreased in the mesenchymal tissue layer surrounding the large airways.

Conclusion: Lower cadherin-26 expression can explain the disturbed mesenchymal/epithelial cell balance and reduced airway branching observed in nitrofen-induced abnormal lung development and CDH.

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Optimal timing for resection of asymptomatic congenital pulmonary airway malformations

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Purpose: It is generally accepted that elective congenital pulmonary airway malformation (CPAM) resections should take place during the first year of life. The optimal timing of operation in that first year is unknown. We, therefore, sought to determine optimal timing for CPAM resection within the first year of life using the National Surgical Quality Improvement Program Pediatric database.

Methods: We queried the National Surgical Quality Improvement Program Pediatric database from 2012-2015 for elective CPAM resections on patients less than 1 year of age. Patients were divided by age in months: 1-3 (n=57), 4-6 (n=135), and 6-12 (n=214). Patient operative variables and 30-day postoperative outcomes were compared. Multivariate logistic regression was performed to identify predictive factors for outcomes.

Results: A total of 406 patients were included with no differences in demographics or comorbidities. Operation time increased with each older age category (115 minutes, 152 minutes, 163 minutes respectively; p=0.01). Thoracoscopic approach was less utilized in 1-3 months (40.4%) compared to the older two age categories (65.9% and 69.6%, respectively; p=0.00). There were no differences by age in major complications, conversion to open, or readmissions. On multivariate analysis, ASA class>=3 (p=0.01) and prolonged operative time (p=0.01) were associated with a major complication. Additionally, multivariate analysis revealed that operations on patients aged 6-12 months were associated with increased operative time (p=0.01) for both open and thoracoscopic procedures.

Conclusion: Elective CPAM resections are equally safe in patients 1-12 months of age. Earlier resection with both open and thoracoscopic resection is associated with decreased operative time.

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Effect of exosomes derived from amniotic fluid stem cells and mesenchymal stem cells on experimental lung injury

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Purpose: We have recently demonstrated that amniotic fluid stem cells (AFSC) exert a beneficial effect on hypoplastic lungs of rat fetuses with congenital diaphragmatic hernia (CDH) via delivery of exosomes. As mesenchymal stem cells (MSC) have proved to accelerate lung growth in clinical trials on preterms with bronchopulmonary dysplasia, we investigated whether MSC-exosomes could exert a similar effect as AFSC-exosomes in vitro.

Methods: Exosomes were isolated from ultra-centrifuged AFSC and bone marrow-MSC conditioned media, quantified (Bradford assay) and assessed for size (nanoparticle tracking), morphology (electron microscopy), and surface markers (Western blot - CD63, Hsp70). A549 epithelial cells were injured using nitrofen (40µM), and cultured for 24h in: i. medium alone; ii. AFSC-exosomes (200µg/ml); or iii. MSC-exosomes (200µg/ml). Untreated A549 cells served as control. Proliferation (5’EdU) and apoptosis (Live/Dead-assay) were compared using one-way ANOVA (Tukey post-test).

Results: Nitrofen administration reduced cell proliferation and increased apoptosis in A549 cells. Treatment with exosomes from both AFSC and MSC rescued proliferation rates to normal levels, but only AFSC-exosomes reversed apoptosis to normal levels (Figure).

Conclusion: Exosomes derived from both AFSC and MSC have growth potential in an in vitro lung injury model. However, AFSC have a greater impact, potentially due to their multipotent nature. The amniotic fluid may represent a better source of stem cells for babies with CDH.
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Evaluation of pre-hospital provider education: a guide to trauma triage and disposition of pediatric and pregnant trauma patients

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Purpose: Trauma is a significant cause of morbidity and mortality with the provision of prehospital care significantly impacting patient outcomes. Factors confounding prehospital care and ultimately triage (ex. pregnancy and adolescence) can negatively affect patient outcomes. Despite a need for transitioning of routine care to adult providers, there is evidence to support improved outcomes for adolescent trauma patients managed at pediatric trauma centers (PTCs) and pregnant trauma victims at adult trauma centers (ATCs).

Methods: A regional survey was administered to prehospital providers identifying significant variability in criteria used to determine patient disposition. A course was then developed by the Injury Prevention Coordinator as a guide to the triage and disposition of pediatric and pregnant trauma patients. Pre- and post-tests were administered to course participants to assess knowledge before and after receiving the education.

Results: A total of 445 participants completed the course at 22 sites; 88 different prehospital provider agencies were represented at the courses. Pre- and post-test was administered to 62% of participants with an average score improvement of 53.4% (pre-test range 30% to 56.6%; post-test range 85% to 100%). Questions addressed different areas of triage education with improvement in test score in all areas (Table 1). Course evaluations scored an average of 4.8/5 in all areas.

Conclusion: Education on triage and disposition guidelines are essential for optimizing patient outcomes. Pre- and post-tests may be used to demonstrate short term efficacy while ongoing evaluations of practice patterns and follow-up surveys demonstrate longevity of acquired knowledge and identify areas in need of further attention.
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1 ATC: Adult Trauma Center, PTC: Pediatric Trauma Center

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Appropriate use of total parenteral nutrition in children with perforated appendicitis

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Purpose: Perforated appendicitis is the most common cause of acute surgical admission, peritonitis, and prolonged ileus in children. Total parenteral nutrition (TPN) is often used in these patients, despite the absence of clear indications. We prospectively assessed the validity of specific clinical indications for initiation of TPN in this patient cohort.

Methods: Data were gathered prospectively on duration of nil per os (NPO) status and TPN use in a cohort of children treated under a perforated appendicitis protocol during a recent 19-month period. By protocol indications, TPN was started only in patients who had severe intestinal dilatation, and diffuse peritonitis with or without an abscess diagnosed at operation. At discharge, TPN was considered to have been used appropriately, according to consensus guidelines, if the patient was NPO ≥ 7 days or received TPN ≥ 5 days.

Results: During the study period, 122 patients were treated for perforated appendicitis. TPN was initiated in 33 (27%) patients. Nineteen patients met one or both consensus guidelines for TPN use during the hospitalization, while 14 did not. Three of 89 patients who did not receive TPN met either guideline. The positive and negative predictive values of our clinical indications for appropriate TPN use were 58% and 97%, respectively.

Conclusion: The presence of severe intestinal dilatation in patients with diffuse peritonitis at operation moderately predicts appropriate TPN use. Patients without these findings should not be placed on TPN. Refinement of selection criteria is necessary to further decrease inappropriate TPN use in children with perforated appendicitis.

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Does size matter? Correlation of ultrasound findings in children without clinical evidence of acute appendicitis

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Purpose: To determine whether children with a positive ultrasound (US) for acute appendicitis but a negative clinical picture developed appendicitis requiring definitive management.

Methods: After obtaining IRB approval, we conducted a retrospective review of patients ≤ 17 years who presented with possible acute appendicitis between April 1st, 2014 and December 31st, 2015. The study included patients with an US suggestive of acute appendicitis based on size criteria but without concerning clinical features such as peritonitis. Patients were discharged from the emergency department (ED) or admitted for observation. Variables included demographic data, US characteristics, clinical findings, length of hospital stay, length of follow-up, and appendectomy.

Results: Of the 31 patients identified, 45% were male and average age was 11.3yrs. On US, the average maximal diameter of the appendix was 6.93mm. 13 patients were admitted, and average length of stay was 0.53 days. The average length of follow-up was 16.5mos, including 11 returns to the ED by 9 patients. Due to repeat imaging and clinical concerns, 3 underwent immediate laparoscopic appendectomy while 1 had interval appendectomy. There were no cases of missed or perforated appendicitis and only 2 cases showed mild inflammatory changes on pathology suggestive of early appendicitis.

Conclusion: Overall, there was a low percentage of readmission for appendicitis after initial ED discharge. These findings demonstrate that children with a positive US for appendicitis based on size criteria but a negative clinical picture can be safely discharged from the ED. Their risk of developing acute appendicitis is similar to the known lifetime risk.

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Epidemiology of pediatric injuries in Rwanda using a prospective trauma registry

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Purpose: Child survival initiatives historically prioritized efforts to reduce child morbidity and mortality due to infectious diseases and maternal conditions. Little attention has been devoted to pediatric injuries in resource-limited settings. This study aims to evaluate the demographics and outcomes of pediatric injury in a sub-Saharan African country in an effort to improve prevention and treatment.

Methods: A prospective trauma registry was established at the two campuses of the University Teaching Hospitals (UTH) in Rwanda to systematically record patient demographics, pre-hospital care, initial physiology, and patient outcomes. Institutional approval was obtained from the University of Virginia and the UTH Ethics Committee. Data were abstracted over the length of data collection from May 2011 to July 2015. Univariate analysis with chi-square and Fisher’s exact test was performed for demographic characteristics, injury mechanisms, geographic location, and outcomes.

Results: Of 11,036 patients in the registry, 3,010 (27.3%) were under age 18. Pediatric patients were predominantly male (69.9%) with a mean age of 8.3 years. Mortality was 4.8%. Falls were the most common injury etiology (45.3%) followed by road traffic collisions (30.9%), burns (10.7%), and blunt force/assault (7.5%). Patients treated in the capital city had a higher incidence of head injury (7.5% vs 2.0%, p<0.0001, OR 4.08, 95% CI 2.6-6.4) and a higher overall injury-related mortality (p<0.001, OR 5.0, 95% CI 3.0-8.4).

Conclusion: Pediatric injury is a significant contributor to morbidity and mortality. Delineating trauma demographics is vitally important when planning resource utilization and capacity-building efforts to address pediatric injury in low-resource settings.

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The "cushion effect" is not protective for children involved in motor vehicle crashes

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Purpose: Analytic Morphomics (AM) applies computational image processing algorithms to cross-sectional images to perform detailed measurements on morphological features in 3D space. Adult data suggests that body composition impacts the risk and pattern of injury in motor vehicle crashes (MVC) with increased BMI protecting against abdominal injuries and pelvic fractures, known as the “cushion effect.” The purpose of this study is to examine the impact of the “cushion effect” on thoracic, abdominal and spine injuries in children involved in frontal MVC.

Methods: Retrospective chart review and AM were performed on 615 patients following MVC. Injury severity was assessed using maximum abbreviated injury score (MAIS) and crash impact rating was derived from crash reporting forms (UD-10). AM measures included visceral fat cross-sectional area, subcutaneous fat cross-sectional area, trabecular bone density and psoas muscle area at L4 vertebral level.

Results: Of the 615 MVC, 212 were frontal crashes and included in the study. The population was 45% male with average age 12.4 ± 5.0 years. Gender, age and impact rating did not correlate with MAIS. Subcutaneous fat cross-sectional area (Figure), visceral fat cross-sectional area, bone density and psoas muscle area did not correlate with injury severity for MAIS 2+ abdominal, thoracic or spinal injuries.

Conclusion: Though subcutaneous fat has correlated with decreased abdominal and pelvic injury in adults, subcutaneous fat does not impact the risk of thoracic, abdominal or spine injuries in children involved in frontal crashes.
Figure 1. Subcutaneous fat cross-sectional area by gender and MAIS

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In harm’s way: unintentional firearm injuries in young children

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Purpose: Firearm-related trauma represents a major source of preventable injury and death in the United States. Studies indicate that many firearm injuries are unintentional, especially in younger children, and previous studies may even underestimate their true incidence. We sought to further characterize the morbidity of unintentional firearm injuries.

Methods: National Trauma Data Bank (NTDB) data from 2007-2014 was analyzed for patients aged 0-14 sustaining gunshot wounds (GSW); we included age, sex, race, injury severity score (ISS), total hospital and ICU length of stay (LOS), ventilator days, discharge to rehab, and mortality. Intention was categorized as assault, unintentional, self-inflicted or other. We compared patients with unintentional firearm injuries against all others using Student’s t-test or chi-square analysis (significant at \( p < 0.05 \)).

Results: Of the 7,487 GSW patients aged 0-14 we identified, 2,514 (33.6%) sustained unintentional injuries. The mortality rate for unintentionally injured patients was 9.2%, compared with 14.2% for all others (\( p < 0.00001 \)). Children with unintentional injuries were more likely to be male (78.8% vs 75.5%, \( p = 0.01 \)) and Caucasian (51.6% vs 22.3%, \( p < 0.00001 \)) than those with other coded intentions. Unintentionally injured children had significantly lower rates of ICU admission (\( p = 0.02 \)), ventilator use (\( p = 0.0004 \)), and discharge to rehab (\( p < 0.00001 \)).

Conclusion: Although unintentional injuries account for less than 10% of GSW-related mortality, they comprise one-third of firearm injuries. Since these injuries are entirely preventable, our findings suggest a major opportunity to reduce disease burden and resource utilization by minimizing these injuries through firearm safety.

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Is appendectomy in children a pediatric surgical procedure?

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Purpose: Pediatric appendectomy is currently performed in Germany either by pediatric (PS) or general surgeons (GS) dependent on regional variations. The here presented investigation was undertaken to reveal differences in quality of care and outcome of pediatric patients following appendectomy performed either by pediatric or general surgeons.

Methods: Routine data (years 2011-2013) were used from the claims to the largest German insurance company Allgemeine Ortskrankenkasse (AOK, 24 million clients). These data were evaluated for the numbers of appendectomies, stages of disease, methods of surgery, complications, unplanned further procedures, mortality and length of hospital stay.

Results: Altogether 30676 patients where included, aged 1-17 years, who were operated in 1074 hospital, 77 with pediatric and 997 with general surgical service. 42% of the patients aged 1-5 years were treated by PS, 22% of the age 6-12 years and 12% of the 13-17 years aged adolescents only. Laparoscopic appendectomy was higher in GS compared to PS (80% vs. 69%). There was a clear higher proportion of complicated appendicitis in PS services (21% vs. 9.5%) and a clear lower number of unspecified appendicitis (8.5% vs. 15%) compared to GS. Length of stay and mortality were similar. There was a trend of slightly higher complication rate in PS services (2.9% vs 2.1%), whereas the rate of secondary surgery was marginally lower (1.6% vs. 1.7%).

Conclusion: This is the largest series of pediatric appendectomies reported from Germany. Pediatric and general surgeons in Germany could perform pediatric appendectomy safely and with comparable quality.

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Is nonoperative management of acute, uncomplicated appendicitis in pediatric patients evidence based?

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Purpose: Nonoperative treatment is being offered as an alternative to appendectomy for pediatric appendicitis. This evidence-based review was undertaken to determine outcomes of nonoperative management compared to appendectomy for acute, uncomplicated appendicitis in pediatric patients.

Methods: Trials published between January 1, 2005-January 31, 2017 were identified through a search of 4 electronic databases and reference lists of included trials. Included studies examined efficacy of antibiotics as first line treatment for nonperforated appendicitis in patients <18 years of age, recording treatment failure, complications and 1 year follow-up. Abstracts were assessed in duplicate, and full articles were assessed for quality using MINORS/Cochrane Risk of Bias.

Results: Of 1332 abstracts screened, 53 full text articles were reviewed and 9 studies (2 retrospective, 6 prospective, and 1 pilot randomized controlled trial) were included, contributing 545 patients for final analysis. 20/250 (8%) patients failed initial nonoperative treatment and were converted to appendectomy. Complication rates, including a 9.6% recurrence rate requiring appendectomy within one year, were higher for nonoperative treatment (37/250, 14.8%) compared to appendectomy (9/295, 3%) [pooled OR 4.61 (95% CI: 1.47,14.46)].

Conclusion: Children and families considering nonoperative treatment for uncomplicated appendicitis should be advised of the 17.6% primary or secondary failure rate and higher complication rate compared to appendectomy. Most studies were of low to moderate quality.

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Safety on the slopes- ski versus snowboard injuries in children

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Purpose: To determine differences in skiing and snowboarding injury patterns and severity in children treated at trauma centers in the United States.

Methods: Ski and snowboard injuries in children <15 identified from the 2011-2014 National Trauma Data Bank were compared using t tests, chi squared tests, and Cochran-Armitage trend tests.

Results: We identified 1424 injured snowboarders and 1356 skiers. Snowboarders were older (mean 13 vs 12 years, p<.001) and more likely to be male (84.1 vs 67.8%, p<.001). The proportion of ski: snowboard injuries at participating hospitals increased over time (p<.001). Skiers were more severely injured (median ISS 5 vs 4, p<.001; 8.4 vs 7.7% ISS≥16, p<.001). Head injuries were common overall (24.9%; AIS ≥3 in 8.4%) and similar between sports despite greater helmet use in injured skiers (43.1 vs 32.2%, p<.001). Skiers were more likely to sustain face, spine, and lower extremity injuries while snowboarders had more abdominal and upper extremity injuries (all p<.05). Snowboarders were more likely to undergo CT. There was no difference in surgical procedures (22.0 vs 20.2%, p=.25), need for intensive care (12.9 vs 13.5%, p=.65), or mortality (0.4 vs 0.3%, p=.75). Median length of stay was longer for injured skiers (2 vs 1 days, p<.001).

Conclusion: Though unlikely to be fatal, many injuries sustained by children while skiing or snowboarding were severe. While these data should inform tailored prevention efforts, it is clear that avoiding head injury and improving helmet use should be priorities for all children on the slopes.

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Long-term outcomes for children with early-onset colitis: implications for surgical outcomes

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Purpose: The timing of J-pouch surgery following colectomy for children with early-onset colitis is controversial, with some authors advocating early reconstruction and others opting to delay reconstruction because of fear that the colitis may be due to Crohn’s disease (CD) rather than ulcerative colitis (UC). We sought to determine the longer-term incidence of CD in this population, and whether there may be clinical features that predict the risk of CD.

Methods: Following IRB approval, all children with a diagnosis of non-infectious chronic colitis who underwent subtotal colectomy and ileostomy prior to age 10 between 2000 and 2015 were reviewed.

Results: There were 25 children (12 male). Median age at presentation was 5.4 years. Four patients were initially diagnosed with CD (16%), 15 with UC (60%), and 6 with inflammatory bowel disease unclassified (IBDU) (24%). Eight eventually had pouch surgery at a median of 2 years after colectomy. Median follow-up was 7.1 years. Five of the children with an initial diagnosis of UC or IBDU developed findings that changed the diagnosis to CD at a median age of 13.4 (range 10.3 to 16.7) years; one had already undergone pouch surgery. None of these five children had any indicators of CD at the initial presentation.

Conclusion: Approximately one quarter of patients with early-onset colitis originally diagnosed as UC or IBDU had a reclassification in diagnosis to CD over time. Based on these data, we recommend that J-pouch reconstruction be delayed until adolescence in children with early-onset colitis.

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Malone appendicostomy versus percutaneous cecostomy tube insertion for children with intractable constipation: a systematic review and meta-analysis

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Purpose: Children with intractable constipation are often treated with antegrade continence enemas. This treatment strategy requires insertion of a Malone appendicostomy in the operating room or percutaneous cecostomy tube by interventional radiology. The purpose of this study was to assess the current evidence regarding these two procedures.

Methods: We conducted a systematic search of Embase, Medline, CINAHL, and Web of Science up to October 2016. We included all comparative studies of children treated with either Malone appendicostomy or percutaneous cecostomy. Two reviewers independently screened abstracts, reviewed studies, and extracted data for meta-analysis.

Results: We identified 166 children from three retrospective studies who underwent either Malone appendicostomy (n=82) or percutaneous cecostomy (n=84). There were no differences between these procedures in terms of the number of patients who achieved continence (80% versus 70%, p=0.76) or experienced fecal leakage (16% versus 18%, p=0.94). The need for additional surgery was significantly higher in children treated with Malone appendicostomy compared to those who underwent percutaneous cecostomy (27% versus 12%, p=0.02). Quality of life was not reported using validated questionnaires in any of the included studies.

Conclusion: Malone appendicostomy and percutaneous cecostomy are comparable in terms of achieving continence and fecal leakage. Children treated with Malone appendicostomy appear to be more likely to require conversion to cecostomy tube or additional surgery due to early or late complications. Prospective, observational studies which include standardized assessments of quality of life are needed to confirm the superiority of one technique over the other.

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Vasoactive intestinal peptide expression is decreased in necrotizing enterocolitis

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Purpose: The enteric nervous system (ENS) plays an important role in intestinal function, including maintenance of gastrointestinal motility and barrier function, via modulation of enteric neuromediators. Impairment in the ENS and release of neuromediators may contribute to necrotizing enterocolitis (NEC) development, although this hypothesis has not been fully explored. The aim of this study was to investigate alterations in neuromediator levels in experimental NEC compared to control.

Methods: NEC was induced in C57BL/6 mice by gavage-feeding of hyperosmolar formula, hypoxia, and lipopolysaccharide administration between postnatal days 5-9 (n=20). Breastfed pups served as control (n=11). On postnatal day 9, the ileum was harvested to score histologically the severity of NEC and to assess mRNA expression of neuromediators by qPCR. The neuromediators evaluated were vasoactive intestinal peptide (VIP), choline acetyltransferase (ChAT), acetylcholinesterase (AchE) and substance-P (SP).

Results: 17 of the 20 pups subjected to our NEC induction protocol developed NEC (histological score ≥2). In the NEC group, expression levels of VIP were significantly decreased compared to control (p<0.001; figure A), whereas there were no differences in ChAT, AchE and SP (figure B, C, D).

Conclusion: VIP expression is reduced in ileum during experimental NEC, indicating impairment in the ENS. This may explain the gastrointestinal dysmotility and barrier dysfunction in neonates with NEC and highlight a potential target for prevention/treatment of NEC.

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Predictors of need for surgical intervention and surgical outcomes in neonates with cystic fibrosis

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Purpose: To identify risk factors for surgery and describe surgical findings/outcomes of neonates with meconium ileus (MI) secondary to cystic fibrosis (CF).

Methods: Retrospective cohort study of neonates with CF presenting between 1997-2015 to a tertiary centre. Chi-square/Fisher’s exact tests were used to examine associations between possible risk factors (sex, prematurity, birthweight, genotype and prenatal bowel echogenicity) and development of MI. For patients requiring surgery, detailed operative findings and outcomes were examined.

Results: MI was diagnosed in 26/120(21.6%) neonates with CF and 19/26(73%) required surgery. Characteristics of the 3 groups are highlighted in the table. Prematurity and lower birthweight were significantly associated with increased risk of MI and operative intervention (p<0.05); genotype and echogenic bowel were not. Surgical data were available for 17/19 patients; median age at surgery was 2 days (IQR1-3), 5/17 had an atresia and 7/17 received an ostomy. Median NICU and hospital stay were 34.5 and 70 days respectively, with no in-hospital mortalities; median time on TPN and time to ostomy reversal were 28.5 and 97 days respectively.

Conclusion: In patients with CF, prematurity and lower birthweight were identified as risk factors for meconium ileus and need for surgery. Specific genotypes and echogenic bowel were not predictors of either. Most patients requiring surgery did so early in life and almost 1/3 had an associated atresia.

Table: Cohort of neonates presenting with Cystic Fibrosis categorized by presence of meconium ileus and need for surgery

<table>
<thead>
<tr>
<th></th>
<th>No meconium ileus</th>
<th>Meconium ileus without</th>
<th>Meconium ileus with surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N (%) or mean (SD)</td>
<td>n/N (%) or mean (SD)</td>
<td>n/N (%) or mean (SD)</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>46/94 (48.94%)</td>
<td>5/7 (71.43%)</td>
<td>11/19 (57.89%)</td>
</tr>
<tr>
<td><strong>Prematurity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/54 (5.56%)</td>
<td>1/7 (14.29%)</td>
<td>6/18 (33.33%)</td>
<td></td>
</tr>
<tr>
<td><strong>Birthweight (in g)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3302 (430)</td>
<td>3405 (705)</td>
<td>2854 (858)</td>
<td></td>
</tr>
<tr>
<td><strong>Genotype</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ508 Homozygous</td>
<td>57/94 (60.64%)</td>
<td>6/7 (85.71%)</td>
<td>11/19 (57.89%)</td>
</tr>
<tr>
<td>Δ508 Heterozygous</td>
<td>25/94 (26.50%)</td>
<td>1/7 (14.29%)</td>
<td>6/19 (31.58%)</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/95 (9.57%)</td>
<td>0/7 (0.00%)</td>
<td>2/19 (10.53%)</td>
<td></td>
</tr>
<tr>
<td><strong>Unknown</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/94 (3.19%)</td>
<td>0/7 (0.00%)</td>
<td>0/19 (0.00%)</td>
<td></td>
</tr>
<tr>
<td><strong>Echogenic bowel on prenatal US</strong></td>
<td>7/26 (26.92%)</td>
<td>2/4 (50.00%)</td>
<td>4/11 (36.36%)</td>
</tr>
</tbody>
</table>
Safety of primary versus delayed repair of low imperforate anus: an analysis of ACS NSQIP-pediatric cases

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Purpose: Posterior sagittal anorectoplasty (PSARP) has become the standard reconstructive approach for children with anorectal malformations. However, there is little data regarding the optimal timing of repair. The purpose of this study was to evaluate the safety of primary versus delayed repair.

Methods: The National Surgical Quality Improvement Program-Pediatric database was queried to identify pediatric patients who underwent PSARP for repair of low imperforate anus with perineal or vestibular fistula from 2012 to 2015. Patients with high defects, cloaca, and bladder extrophy were excluded. Patients undergoing early primary repair (0-7 days) were compared with those undergoing delayed repair (6 weeks to 8 months). The groups were propensity scored with a non-parsimonious regression model and matched 1:1 without replacement. 30-day outcomes, including wound complications, reoperations, and readmissions, were compared between groups.

Results: A total of 280 patients were identified (102 primary, 178 delayed.) Propensity score matching yielded two groups of 75 patients with minimal covariate imbalance. There was no significant difference between early and delayed repair in wound complications (10.7% vs 5.3%, p=0.23), reoperation (8.0% vs 4.0%, p=0.30), or readmission (1.3% vs 1.3% p=1.00). Mean operative time was longer in those undergoing delayed repair (108 vs 65 minutes, p<0.01).

Conclusion: Analysis of this large multicenter dataset demonstrates safety of primary PSARP for low anorectal defects, with no increase in 30-day complications compared to delayed repair. While this study does not account for individual surgeon experience, our analysis concludes that timing alone is not a significant predictor of short term outcomes.

<table>
<thead>
<tr>
<th>Outcome Variable N (%)</th>
<th>Primary repair (n = 75)</th>
<th>Delayed Repair (n = 75)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound Complications</td>
<td>8 (10.7%)</td>
<td>4 (5.3%)</td>
<td>0.2</td>
</tr>
<tr>
<td>Reoperation</td>
<td>6 (8.0%)</td>
<td>3 (4.0%)</td>
<td>0.3</td>
</tr>
<tr>
<td>Readmission</td>
<td>1 (1.3%)</td>
<td>1 (1.3%)</td>
<td>1.0</td>
</tr>
</tbody>
</table>
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Quantifying and predicting benefit from pediatric sacral nerve stimulation for severe constipation and fecal incontinence

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Purpose: Sacral nerve stimulation (SNS) is used to treat severe constipation and fecal incontinence in children. Though symptomatic improvement occurs in some patients, there is no objective method for identifying those who will benefit from therapy. We used a validated symptom scale, including stooling and enema scores, to compare patients who benefited from SNS with those who did not.

Methods: After IRB approval, composite stooling and enema scores were analyzed for children with refractory constipation or incontinence undergoing SNS at our institution from 11/2014 – 11/2016 (n=14). Stooling diaries were used to calculate scores at baseline, after temporary electrode implantation (Stage I), after permanent device implantation (Stage II), and after device removal if applicable. Results were compared using paired t-tests, with p<.05 considered significant.

Results: Fourteen patients underwent Stage I implantation. Age ranged from 4.2 to 18.8 years. Nine patients had constipation and 5 had incontinence. Two patients underwent explant before Stage II due to lack of benefit, 1 patient suffered infection, and 11 patients underwent Stage II. Of these, 3 patients underwent explant due to lack of benefit. In all patients who underwent explant due to lack of benefit, mean composite score was 17.4±7.9 before Stage I, and 15.8±7.0 after (p=0.20), with scores after Stage II of 17.7± 8.1 (p=0.96). For patients who benefited, mean composite score was 17.8±10.9 before Stage I, and 12.0±6.1 after (p=0.05), with scores after Stage II of 8.2± 4.6 (p=0.03).

Conclusion: Composite stooling and enema scores after Stage I implantation predict benefit from SNS.

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Gastroschisis treatment and outcomes before and after multidisciplinary care standardization

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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. The purpose of this study was to compare treatment, outcomes and resource utilization before and after standardization.

Methods: An interdisciplinary (neonatology, surgery, nursing, MFM, anesthesia, antibiotic stewardship) team utilized best practice evidence and expert opinion to standardize GS care. Following stakeholder engagement and education, care standardization (supported by pre-printed orders and bedside nursing policies) was implemented in September 2014. A comparative cohort study was conducted on consecutive patients treated before (n=32) and after (n=25) standardization. Demographic, treatment and outcome measures were collected from a prospective GS registry. Compliance with key processes was recorded.

Results: BW, GA and bowel injury score were comparable between groups. Key practice changes were: closure technique (pre-91% primary fascial, post-84% umbilical cord flap; p<0.0001), closure location (pre-100% OR, post-84% NICU; p<0.0001) and avoidance of general anesthesia (pre-0%, post-48%; p<0.0001). Post-closure ventilation was shorter (5.6+/−5.3d vs 1.9+/−3d; p=0.003) and SSI rates trended lower (pre-22%, post-8%; p=0.06), in the post-implementation group, with no differences in TPN days, time to full feeds or LOS. Compliance with antibiotic, sedation and vascular access protocols approached 100%. In response to 3 post-implementation sedation failures, the sedation policy was modified.

Conclusion: Care standardization for GS permits practice transformation, which is responsive to unanticipated outcomes. In addition to outcome improvement with expended resource reduction, standardization supports an organizational culture dedicated to improvement.

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Which surgical method results in best outcomes in pediatric patients with Hirschsprung disease? A network meta-analysis investigating Duhamel, Swenson, and Soave

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Purpose: To conduct a network meta-analysis to determine which surgical method produces best outcomes in pediatric patients with Hirschsprung disease.

Methods: A systematic search of MEDLINE, Embase, CENTRAL, and CINAL was conducted in December 2016. Identified citations were screened independently in duplicate and data were extracted on the clinical outcomes. A Bayesian network meta-analysis using a random effects model with vague priors was used to pool and compare outcomes between surgical methods, and Markov chain Monte Carlo methods were used to model summary odds ratios (OR) with 95% credible intervals (CrI).

Results: 35 studies evaluating 2,830 patients were included. Patients treated with the Soave method had reduced odds of enterocolitis (OR 0.79, 95% CrI 0.44-1.34 for Duhamel; OR 0.47, 95% CrI 0.23-0.82 for Swenson; Tau2 0.610), constipation (OR 0.33, 95% CrI 0.11-0.83 for Duhamel; OR 0.23, 95% CrI 0.07-0.69 for Swenson; Tau2 1.325), and incontinence (OR 0.95, 95% CrI 0.39-2.31 for Swenson; OR 0.84, 95% CrI 0.35-1.79 Duhamel; Tau2 0.4599). Duhamel was favoured for the outcomes of mortality (OR 0.94, 95% credible interval (CrI) 0.31-2.73 for Soave; OR 0.47, 95% CrI 0.15-1.23 for Swenson; Tau2 0.67), anastomotic leak (OR 0.51, 95% CrI 0.12-2.08 for Soave; OR 0.40, 95% CrI 0.08-1.76 for Swenson; Tau2 1.55), and stenosis (OR 0.28, 95% CrI 0.08-1.0 for Swenson; OR 0.19, 95% CrI 0.05-0.60 for Soave; Tau2 1.46).

Conclusion: The best surgical treatment was outcome dependent, with both Duhamel and Soave being favoured in 3 outcomes each. For the majority of outcomes, Swenson was ranked the worst surgical treatment.

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Liver damage in necrotizing enterocolitis

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Purpose: Necrotizing enterocolitis (NEC) is known to cause multi-organ injury including liver. LGR5 is a marker of hepatic progenitor cells which are needed to recover liver damage. We aimed to investigate LGR5 expression in the liver in experimental NEC.

Methods: Following ethical approval (#32238), NEC was induced for C57BL/6 mice by giving hypoxia, gavage feeding of hyperosmolar formula and lipopolysaccharide administration. Controls were breastfed pups kept with the mother. We analyzed serum ALT level, liver inflammatory response (qPCR) and liver LGR5 expression (qPCR and western blotting). Comparison was made between NEC and control.

Results: Serum ALT level and liver IL6 mRNA expression were higher in NEC compared to control (serum ALT: p<0.05. IL6 expression; p<0.05) (Figure A, B). Liver neutrophil infiltration was confirmed by MPO staining. Conversely, LGR5 was significantly decreased in NEC compared to control as demonstrated by mRNA (qPCR: p<0.05) and protein level (western blotting: p<0.01) in the NEC liver (Figure C, D).

Conclusion: We discovered that an inflammatory injury is present in the liver during experimental NEC. Similarly, liver LGR5 expression is impaired in NEC compared to control. Further studies are needed to be evaluated if modulation of progenitor cell expressing LGR5 can result in reduced NEC-induced liver injury and eventually in improved clinical outcome.
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Feeding tube system with base balloon

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Abstract: Common problems associated with existing trans-abdominal feeding devices are; post-insertion stomach-abdominal wall dehiscence, parastomal leak, wound irritation caused by tube movement and the need to keep different sizes in-stock. We have tried to address these problems.

Invention description: A feeding tube system similar to MIC-KEY™ with a distal retention intra-gastric balloon and another set of balloons attached to the proximal bases horizontal flanges. It is configured in a way to inflate toward the abdominal wall.

Proposed action: Once inserted and the retention balloon is inflated the base balloons can be gradual inflated downward lifting the tube away from the abdominal wall. A valve will keep the balloons inflated at the desired size.

Potential advantages:

- Stabilizes the tube and minimizes its movements
- A single tube length can be adjusted for use on different patients’ sizes
- Upward traction improves internal balloon seal and prevent leak
- Minimizes the risk of gastric-abdominal wall dehiscence immediately after insertion
Sponsoring CAPS member: Dickens Saint-Vil

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Three dimensional body scans for an objective measurement of pectus carinatum deformities

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4 Braceworks, Inc, Calgary, Alberta

Purpose: Clinical measurements of pectus carinatum deformity vary by clinician, often performed with tape measure or calipers. We propose the use of three dimensional body scans to quantify chest dimensions and severity of pectus deformities.

Methods: Patients were recruited for study at time of brace fitting for pectus carinatum (ethics approved). Patients were measured by an experienced clinician with calipers to identify the anterior-posterior and transverse dimensions of the chest. A three dimensional body scan was performed, converted to an axial image and deformity dimensions were obtained for comparison (Figure 1). Pearson correlation coefficients were calculated.

Results: Between October 2016 and February 2017, 13 male patients were enrolled at initiation of pectus carinatum treatment (median age 14, range 12-17). The calculated Pearson correlation coefficients for anterior-posterior and transverse chest dimensions were 0.7 and 0.5, respectively.

Conclusion: There is positive correlation between three dimensional body scan and clinical measurements. Three dimensional scanning is easily implemented in the clinic setting and may be a more objective measure of deformity severity and treatment success over time. Future study is required to better characterize individualized pectus carinatum therapy as well as a potential role in reducing ionizing radiation in the work up of pectus excavatum.
Figure 1. Sagittal view of three dimensional body scan with level of greatest protrusion marked (left). Axial image at greatest protrusion with transverse and anterior-posterior dimensions (right).

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Single incision laparoscopic resection of a giant ovarian mature cystic teratoma

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Abstract: Ovarian tumors are rare in the pediatric population. Historically, resection was performed via laparotomy, though laparoscopic and Single Incision Laparoscopic Surgery (SILS) approaches are well documented in the literature. We present a video demonstrating the use of the SILS technique for removal of a giant ovarian mature cystic teratoma in a child. A 13-year old girl presented with a one-year history of abdominal fullness and significantly protuberant abdomen. Ultrasonography and CT scan demonstrated a 32 x 15 x 27 cm fluid-filled cyst with calcifications, suggestive of a left ovarian teratoma. Given the patient's normal tumor markers and low risk of malignancy, a SILS resection was undertaken. The patient tolerated the procedure well and was discharged home on the first postoperative day. Pathology demonstrated an ovarian mature cystic teratoma. This case is of particular interest given the impressive size of the cystic mass, and its successful resection via the SILS technique.

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The novel use of preoperative embolization with n-butyl cyanoacrylate prior to surgical resection of venous malformations

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Purpose: To report a novel technique of preoperative use of n-Butyl Cyanoacrylate as a glue embolization procedure followed immediately by surgical resection of venous malformations.

Methods: A single center IRB approved retrospective chart review of all patients who underwent glue embolization followed immediately by surgical resection. Demographics of the patients, characteristics of the venous malformation were reviewed and postoperative course was examined.

Results: 7 patients were identified who underwent this procedure. Mean age of patient were 10.8±4.9 years old. Locations of the venous malformations were head/neck in three patients, chest wall in one patient, perineum one patient and upper extremity. 5/7 patients had previously undergone multiple sclerotherapy procedures (5.2±4.4 procedures) and 2 patients had undergone partial surgical debulking with minimal success. The technique involves the direct injection of n-Butyl Cyanoacrylate under ultrasound and fluoroscopic guidance by an interventional radiologist. The patients were then taken directly to the operating room and underwent resection. All surgical resections were done without the need for perioperative transfusion and no complications mean follow up of 2.1 years ranging 0.5 to 6 years.

Conclusion: This is the first report of the use of pre-operative n-Butyl Cyanoacrylate embolization for surgical resection of otherwise unresectable venous malformations with excellent long term results.

Preop MRI
Preoperative glue embolization

Post op

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Dressed for success? - silver impregnated dressing for initial treatment of giant omphalocele

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Purpose: Use of daily silver sulfadiazine dressings for the treatment of giant omphalocele (GO) is well established. Recently, our institution began using twice-weekly silver impregnated dressings for GO patients. The purpose of this study was to assess the outcomes and resource utilization in patients with GO treated with silver impregnated dressings.

Methods: A retrospective review (Jan 2015 to Dec 2016) of patients with GO treated with twice weekly changes using silver impregnated dressings was undertaken. Measured parameters included gestational age, birth weight, GO size, ventilator days, NICU days, time to full feeds, time to discharge, length of stay, time to closure, and cost.

Results: Five patients were treated with silver impregnated dressings. No ruptures occurred. There was 1 mortality (pulmonary infection). Gestational age, birth weight and GO size were 34 ± 4wks, 2.5 ± 0.62kg, and 10.2 ± 4.7cm respectively. Ventilator days, days in NICU, and LOS were 7.5 ± 8.7d, 40 ± 20d, and 62 ± 41d, respectively. Time to full feeds was 30 ± 15d. On discharge, all were receiving dressing changes. Two patients had delayed primary closure at 546 and 441 days; two are awaiting OR. Average cost of silver impregnated dressings was $110/week vs. daily silver sulfadiazine at $109/week.

Conclusion: In our experience, compared to daily silver sulfadiazine dressings, silver impregnated dressings resulted in decreased handling of infants as well as decreased physician and nursing resource utilization at a comparable cost. Further comparison of patient outcomes to the silver sulfadiazine treated group will be important.

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Thoracoscopic management of a vascular complication following central line placement

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Abstract: This video presentation demonstrates the management of a right brachiocephalic vein injury in a 7-month old patient after line insertion in the right internal jugular vein by percutaneous access, using ultrasound guidance. Direct compression of injury and repositioning of catheter using a thoracoscopic approach was performed. The patient recovered well and was discharged home on the 4th post-operative day. The port-a-cath was salvaged and there hasn’t been a complication since (> 2 year follow-up). This case demonstrates that a thoracoscopic approach can be considered when dealing with a vascular complication from central venous catheter insertion. In highly-selected patients, this approach may save patients from significantly more morbid incisions.

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Enrollment and reporting practices in pediatric general surgical randomized clinical trials

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Purpose: Pediatric surgical randomized clinical trials (RCTs) are labour-intensive and costly. This systematic review investigated patient accrual and estimates of study duration in RCTs by interrogating enrollment and registration practices.

Methods: With librarian oversight, we performed a peer-reviewed search of multiple databases from 2000-2016 evaluating RCTs salient to the field – inclusion mandated that a self-identified pediatric surgeon be listed as an author. Published and unpublished trials were further investigated via online trial registries. RCTs were appraised using two validated tools; predictors of success were evaluated using multivariate logistic regression, with success defined as achievement of recruitment objectives.

Results: After screening, 137 RCTs were analyzed; mean Jadad score was 1.80 (median=2). CONSORT scores ranged between 17-97% (median=58%). Sixty-seven studies described sample-size determination, 49 reported projected enrolment and 26 were successful. Among 26 registered RCTs, 15 disclosed their expected completion date, which was achieved by 8. On average, protocols underwent 3.42 iterations. 9% of trials were terminated before completion, most commonly due to poor recruitment. Trial registration and urgent cases significantly predicted success on univariate analysis (p<0.05, Table 1).

Conclusion: Overall quality of reporting in pediatric surgical trials is poor. Sample-size calculation and patient accrual is frequently poorly performed or under-estimated, resulting in trial overrun and/or premature termination. These data may help to inform subsequent study design and facilitate successful completion.
Table 1. Baseline characteristics of successful and unsuccessful pediatric general surgery RCTs along with crude Odds Ratios, adjusted Odds Ratios and respective 95% confidence intervals derived from univariate and multi-variable logistic regression analyses.

<table>
<thead>
<tr>
<th></th>
<th>Successful (N=26)</th>
<th>Unsuccessful (N=111)</th>
<th>Crude Odds Ratio (95% Confidence Interval); p-value</th>
<th>Adjusted Odds Ratio (95% Confidence Interval); p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered</td>
<td>11 (42%)</td>
<td>15 (14%)</td>
<td>4.69 (1.80, 12.23); 0.001</td>
<td>2.96 (0.93, 9.74); 0.068</td>
</tr>
<tr>
<td>Funded</td>
<td>5 (19%)</td>
<td>19 (17%)</td>
<td>1.15 (0.35, 3.26); 0.829</td>
<td>NS</td>
</tr>
<tr>
<td>Surgical Outcome</td>
<td>17 (65%)</td>
<td>67 (61%)</td>
<td>1.00 (ref.)</td>
<td>NS</td>
</tr>
<tr>
<td>Drug Outcome</td>
<td>7 (27%)</td>
<td>31 (28%)</td>
<td>0.89 (0.32, 2.30); 0.815</td>
<td>NS</td>
</tr>
<tr>
<td>Fetal</td>
<td>0 (0%)</td>
<td>2 (2%)</td>
<td>0.00 (0.00, 9.86e+63); 0.989</td>
<td>NS</td>
</tr>
<tr>
<td>Urgent</td>
<td>17 (65%)</td>
<td>42 (38%)</td>
<td>3.10 (1.29, 7.88); 0.013</td>
<td>2.99 (0.78, 12.60); 0.120</td>
</tr>
<tr>
<td>Life-threatening</td>
<td>16 (62%)</td>
<td>47 (43%)</td>
<td>2.42 (1.00, 6.17); 0.054</td>
<td>0.88 (0.22, 3.40); 0.853</td>
</tr>
<tr>
<td>Multi-centric</td>
<td>5 (19%)</td>
<td>33 (30%)</td>
<td>0.56 (0.18, 1.52); 0.286</td>
<td>NS</td>
</tr>
<tr>
<td>English language</td>
<td>13 (50%)</td>
<td>33 (30%)</td>
<td>2.36 (0.99, 5.69); 0.053</td>
<td>1.25 (0.40, 3.64); 0.694</td>
</tr>
</tbody>
</table>

1. Crude Odds Ratio
2. 95% Confidence Interval
3. Adjusted Odds Ratio
4. Not Significant - refers to the variables excluded from the multi-variable logistic regression model based on univariate p-value > 0.1

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Variation of access to pediatric surgical care among coexisting public and private providers: inguinal hernia as a model

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Purpose: Privatization in health care is increasingly seen as an alternative tool to improve access to care. We used inguinal herniotomy (IH) as a model to compare the variation in access to pediatric surgical services between two large coexisting public (PB) and private providers (PV).

Methods: Children who had IH between May 2010 and December 2014 at both providers were reviewed. Data collected included patient demographics, insurance coverage, referral pattern, time to surgeon (TTS), surgery wait time (SWT) and duration of symptoms (DOS).

Results: A total of 574 IH cases were reviewed. We included 290 PB and 228 PV cases after excluding 56 cases of in-hospital referrals. PV patients were younger (12 vs 16.4 months, p=0.043) and more likely to be boys (81.6% vs 72.8%, p=0.019), expatriates (18% vs 3.4%, p<0.001) and insured (47.4% vs 0%, p<0.001). The emergency department was the main source for PB referrals (35.2% vs 12.47%, p<0.001) while most PV patients were self-referred (72.8% vs 16.7%, p<0.001). All PV access parameters were remarkably better including TTS (21 vs 66 days, p<0.001), SWT (4 vs 31 days, p<0.001) and DOS (33 vs 114 days, p<0.001).

Conclusion: In a mixed public and private system, PV patients have better access to pediatric surgery services. Diverting public funds to improve children's insurance coverage and hence access to PV could be a valid alternative to improve their access however, variation in quality of care should be monitored.

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Natural talent: myth or reality? The ability to learn laparoscopic surgery

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Purpose: To identify learning curve patterns in pediatric laparoscopy and their relationships with participants’ visual function.

Methods: Fourteen laparoscopy naïve participants performed 10 repetitions of the object transfer task on a validated pediatric laparoscopic simulator following preliminary visual function assessment (Randot test). Motion analysis software was used to track instrument movements and assess performance. Proficiency was determined using validated criteria thresholds for task completion time (<107 seconds) and total instruments distance (<2.03 meters). Research Ethics Board Approval: HS20361. Learning curve patterns were analyzed using the Friedman ANOVA test.

Results: We identified 4 distinct learning curve patterns. Participants in Group 1 (28.5%, n=4) achieved pre-defined proficiency level ≤5 sessions, and demonstrated significant learning curves (completion time p=0.001, instruments distance p=0.045). Group 2 (28.5%, n=4) achieved pre-defined proficiency level >5 sessions, with significant learning curves (completion time p=0.003, instruments distance p=0.033). Group 3 (28.5%, n=4) failed to achieve proficiency but still showed progressive improvement (completion time p=0.007, instruments distance p=0.034). Group 4 (14.5%, n=2) failed to achieve the proficiency level without performance improvement (p=0.096 and p=0.128 respectively). All participants had normal visual function, with stereo acuity between 20” and 50”, and no significant differences among groups.

Conclusion: This study demonstrates different abilities to learn laparoscopy. Most participants improved their performance during the training sessions, with variation in learning speed. A distinct group of poor learners was identified. No relationship was identified between visual function and learning curve patterns. Further research is required to understand why subjects learn laparoscopy at differing rates.

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Enhanced self-perceptions of professionalism following a professionalism education program in general surgery residents

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Purpose: Unprofessional behaviour in the medical profession is at a publicly exposed, all-time high. Despite mounting concerns in medical schools, residency and fellowship programs, there is a lack of formal education and program development regarding professional behaviour. In light of these issues, the development of a program designed to educate and develop professionalism among General Surgery residents at the University of Manitoba was implemented.

Methods: 26 General Surgery residents took part in a 6-month Professionalism Education Program. A previously validated survey was administered pre and post program, measuring change in self-perceptions of professionalism. Extraction of common themes related to self-perceptions of professionalism was achieved through assessment by qualitative surveys and standardized interviews.

Results: A total of 24/26 pre survey, 16/26 post survey, and 12/26 follow-up responses were collected. In addition, 4 residents participated in an exit interview. Improvement in self-perceptions of professionalism were demonstrated in each of the seven core principles, with particular significance in the areas of social responsibility and integrity. Thematic analysis of the qualitative data revealed improved awareness of professional issues, self-perceptions of behaviour, and ability to utilize strategies learned in the Professionalism Education Program to improve professional behaviour.

Conclusion: Our program demonstrated improvements in self-perceptions of professionalism, increased awareness of unprofessional behaviour and the ability to utilize strategies that improve professionalism, all of particular importance in surgical programs/fellowships where communication, skill, and behaviour are under constant scrutiny. Our innovative program can be used to successfully improve trainee self-perceptions of professionalism and should be considered in other specialties and programs.

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A simulated training model for laparoscopic pyloromyotomy: is 3D printing the future?

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Purpose: Hypertrophic pyloric stenosis (HPS) is a common neonatal condition treated with open or laparoscopic pyloromyotomy. 3D-printed organs offer realistic simulations to practice surgical techniques. The purpose of our study was to validate a 3D HPS stomach model using a Global Operative Assessment of Laparoscopic Skills (GOALS) and assess the model’s reliability and surgical realism.

Methods: Medical students, general surgery residents, and adult and pediatric general surgeons were recruited from a single center. Each participant was videotaped three times performing a laparoscopic pyloromyotomy using box trainers and 3D-printed stomachs. Each attempt was graded independently by three reviewers using GOALS and task specific assessments (TSA). Participants were surveyed using the Index of Agreement of Assertions on Model Accuracy (IAAMA).

Results: Of 30 participants, 27 had all three attempts recorded. Participants reported their experience levels as novice (22%), inexperienced (26%), intermediate (18.5%), and experienced (33%). Inter-observer variability was not significant between raters for both overall average GOALS and TSA scores. There was a significant improvement in GOALS (p<0.0001) and TSA scores (p=0.03) between attempts and overall. These improvements were not significant when examined by participant experience level. The majority of participants felt the model accurately simulated a laparoscopic pyloromyotomy (82%) and would be a useful tool for beginners (100%); although this was not statistically significant.

Conclusion: A 3D-printed neonatal stomach model for simulated laparoscopic pyloromyotomy is a useful training tool for learners to improve their laparoscopic skills. It is also a useful tool to assess intraoperative laparoscopic skills with minimal intra-observer variability.

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I-PASS enhances effectiveness and accuracy of handover for pediatric general surgery patients

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Purpose: I-PASS is a validated and standardized handover protocol shown to reduce medical error and improve handover efficiency in the pediatric medical population. Our aim was to evaluate the effectiveness, accuracy and resident satisfaction of implementing I-PASS on a pediatric surgery service.

Methods: A prospective intervention Quality Improvement (QI approved) study was utilized to evaluate resident written and verbal handovers before and after implementation of I-PASS on a large pediatric surgery service at a tertiary center. I-PASS was implemented using handover training seminars and a printed handover tool linked to the electronic medical record (EMR). Completeness of the written and verbal handover was compared pre-and post-implementation using the following elements: illness severity, patient summary, action list, situation awareness, contingency planning and receiver synthesis. Accuracy was compared against the patient EMR. Anonymous surveys were completed by residents following each observation. Results were analyzed using T/Mann-Whitney U Tests and Chi Square.

Results: A total of 49 written tools and 50 verbal handovers were compared pre-and post I-PASS implementation. With I-PASS, increased written accuracy was observed in the documentation of the patient summary due to auto-population of elements by EMR (p<0.05). Accuracy in the verbal handover of illness severity, patient summary, contingency plan, action list and synthesis also improved (p<0.05); but duration of handover increased (p<0.01). Post implementation surveys of residents demonstrated an increased understanding of patient management (p<0.05).

Conclusion: Implementing I-PASS on a pediatric surgery service improved the effectiveness and accuracy of patient handover with increased resident satisfaction. Sustainability requires specialized training of new residents.

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Development of an innovative pathway for the design and manufacturing of surgical devices using a steel three-dimensional (3D) printer

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Purpose: Surgeons are in a unique position to be innovators, identifying gaps, thinking of improvements and even designing new tools. However, realizing these innovations is costly and requires navigating design, manufacturing, commercialization and regulatory difficulties that clinicians are rarely equipped for. This innovative program aims to decrease the barrier to design, development and testing of surgical instruments and create a platform to develop such innovations and bring them to daily practice.

Methods: An appropriate surgical instrument (hernia spoon) was identified as a desired instrument by multiple pediatric surgeons in Canada but without an established manufacturer. Iterative design development was undertaken between surgeons and designers. Once the design was agreed upon, a prototype was generated using a steel 3D printer, with 2 subsequent rounds of edits ending up with a satisfactory design. The printed product was evaluated by practicing pediatric surgeons and other stakeholders, regarding ergonomics and usability of the device and is currently being assessed for sterilization parameters and regulatory approvals.

Results: A comprehensive design, prototyping and commercialization process was conceptualized, developed and trialed using the hernia spoon as a case study. Three spoon prototypes were developed using 3D printing, incorporating improvements prior to finalization.

Conclusion: This proof of concept study provides evidence that 3D printing of surgical instruments within a developed design, manufacturing and commercialization process can bring down the barriers to surgical innovation. This has far reaching implications for resource rich and limited settings, the ability to specialize instrument modifications, and cost-reduction initiatives related to surgery.

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Imaging of fetal abdominal organs using in vivo two-photon laser-scanning microscopy

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3 Department of Gastrointestinal and Pediatric Surgery, Mie University Graduate School of Medicine, Tsu, Mie, Japan

Purpose: The intra-abdominal organ circulation during embryonic organ development needs to be investigated to understand the embryogenesis of diseases. The aim of this study is establishing a live fetal intra-abdominal imaging during placental circulation using two-photon laser-scanning microscopy (TPLSM).

Methods: Following ethical approval (n.4886), pregnant mTmG transgenic mouse were placed on the microscope stage under general anesthesia. A portion of the uterus containing one fetus was transferred out of the abdominal cavity. The uterus was cut and the placenta was identified (Figure A, blue arrow). Fetuses were placed on sterile gauze in a platform (Figure A, red arrow), after ensuring that the umbilical cord was not twisted or tangled (Figure A, yellow arrow). To ensure a stable and consistent observation area, a holding device was designed to prevent movement during observation and recording (Figure B).

Results: Live fetal intra-abdominal images were obtained without opening the fetal abdominal wall, and while maintaining continuous blood supply through the umbilical cord. During the observation, leukocytes (Figure C, yellow arrow), platelets (Figure C, red arrow) and fetal red blood cells were identified.

Conclusion: Fetal TPLSM enables live imaging of intra-abdominal organs. This exiting novel in vivo technique can enhance (i) the current understanding of prenatal development of congenital anomalies and (ii) the evaluation of fetal therapeutic maneuvers.
Figure

A  
B  
C

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Risk factors for surgical site infection in neonates: a systematic review and meta-analysis

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Purpose: To evaluate the prevalence and identify risk factors for surgical site infections (SSI) in neonates.

Methods: Using a defined strategy (PubMed, Medline, Cochrane databases), two investigators independently searched articles on neonatal SSI published between 2000 and 2016. Studies on neonates (<44wks gestational age) and/or patients admitted to neonatal intensive care unit following cervical/thoracic/abdominal surgery were included. Case reports, animal studies and opinion articles were excluded. Risk factors were identified from comparative studies. Meta-analysis was conducted according to PRISMA guidelines using RevMan 5.3. Data are expressed as mean±SD.

Results: Systematic review - of 553 abstracts screened, 29 articles (3,456 patients) met the search criteria (no prospective or randomized studies). The incidence of SSI was 12% (416 patients). SSI was more frequent in males (66%), premature babies (77%) and following abdominal surgery (88%). Meta-analysis - four comparative studies (1,238 patients; 91 (7%) cases of SSI) showed that predictive factors for SSI development are age at surgery and length of surgical procedure (Figure 1A, B). Conversely, there were no differences between neonates developing SSI and control (no SSI) for gestational age (33±0.4 vs 32±0.5, p=ns) and birth weight (2121±74 vs 1993±284.7, p=ns).

Conclusion: Older neonates and those undergoing abdominal procedures are at higher risk for SSI. Given the lack of evidence-based literature, prospective studies may help determine the risk factors for SSI in neonates.
### Fig. 1

#### A

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>SSI Mean</th>
<th>SD</th>
<th>Total</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Mean Difference</th>
<th>IV, Fixed, 95% CI</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rojo et al. 2012</td>
<td>35 5</td>
<td>13</td>
<td>36</td>
<td>5.3</td>
<td>50</td>
<td>21</td>
<td>11.4%</td>
<td>-1.00 (-4.09, 2.09)</td>
<td>2012</td>
<td></td>
</tr>
<tr>
<td>Segal et al. 2014</td>
<td>45 4</td>
<td>38</td>
<td>34.5</td>
<td>1.5</td>
<td>686</td>
<td>66.9%</td>
<td>10.50 (9.22, 11.78)</td>
<td>2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clements et al. 2016</td>
<td>38 6</td>
<td>29</td>
<td>36</td>
<td>3</td>
<td>136</td>
<td>21.7%</td>
<td>2.00 (-0.24, 4.24)</td>
<td>2016</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total (95% CI): 80 872 100.0% 7.34 [6.30, 8.39]

Heterogeneity: $\chi^2 = 73.33$, df = 2 ($P < 0.00001$); $I^2 = 97$

Test for overall effect: $Z = 13.78$ ($P < 0.00001$)

#### B

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>SSI Mean</th>
<th>SD</th>
<th>Total</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Mean Difference</th>
<th>IV, Fixed, 95% CI</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rojo et al. 2012</td>
<td>100.8</td>
<td>49.6</td>
<td>13</td>
<td>51.6</td>
<td>50</td>
<td>6.4%</td>
<td>-7.20</td>
<td>-37.72, 23.32</td>
<td>2012</td>
<td></td>
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<tr>
<td>Laja et al. 2013</td>
<td>70 14</td>
<td>13</td>
<td>44</td>
<td>14</td>
<td>275</td>
<td>83.7%</td>
<td>26.00</td>
<td>17.56, 34.44</td>
<td>2013</td>
<td></td>
</tr>
</tbody>
</table>

Total (95% CI): 83 461 100.0% 23.48 [15.76, 31.20]

Heterogeneity: $\chi^2 = 4.24$, df = 2 ($P = 0.12$); $I^2 = 53$

Test for overall effect: $Z = 5.96$ ($P < 0.00001$)
Global pediatric surgical workforce and surgical outcomes: defining a critical provider density for improved survival

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Purpose: Low and middle-income countries have only 19% of the global surgical workforce, yet 80% of deaths from non-communicable diseases occur in these regions. We aimed to evaluate the association between pediatric surgical workforce density (PSWD) and survival from pediatric surgical conditions worldwide.

Methods: Online databases were searched for national outcome studies for four pediatric surgical conditions (gastroschisis, esophageal atresia, neonatal bowel obstruction and typhoid perforation) across low-income (LIC), middle-income (MIC) and high-income countries (HIC). PSWD, obtained through pediatric and/or surgical professional organizations, was expressed as number of surgeons/million children (under 14 years-old) and correlated to surgical outcomes.

Results: Outcomes of at least one of the four conditions studied were obtained for 39 countries: 10 HIC, 16 MIC and 13 LIC. PSWD ranged between 0.12 (Mali) - 29.4 (United Kingdom). The mean survival (± standard deviation) was 39.1% (± 32.8), 67.2% (± 24.9) and 91.2% (±12.4) for LIC, MIC and HIC, respectively. Overall survival >80% required a minimum of 4.4 surgeons/million children (p<0.0001, 95%CI [1.96; 10.98], RR 4.34). Across the studied LIC and MIC, increasing the PSWD to 4.4 would require training 2,835 additional surgeons but would result in 8,492 fatalities averted yearly from gastroschisis, esophageal atresia and neonatal bowel obstruction.

Conclusion: Scaling up global PSWD is a priority for reducing global pediatric surgical mortality.
Overall Survival (All Conditions)

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Quantifying delays and self-identified barriers to timely access to pediatric surgery at Mbarara Regional Referral Hospital, Uganda

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Purpose: Favorable surgical outcomes depend on timely access to care. A previous study documented delayed access to pediatric surgical care at a Ugandan referral hospital. The current study quantifies these delays and explores caregiver barriers to access.

Methods: An interviewer-facilitated survey was administered over 4 months to consecutive families of pediatric surgical patients admitted to Mbarara Regional Referral Hospital (MRRH). Delays in care were classified using the Three Delay Model: care-seeking (Type 1), arrival at health facility (Type 2), and time to surgery (Type 3). Barriers at each stage were explored with caregivers.

Results: The survey included 117 patients (45% congenital anomalies, 29% hernias, 13% tumors, 13% miscellaneous acute conditions). Family members were first to recognize disease in 94%, but only 20% reported seeking medical attention immediately. Delays in seeking care (1 day-4 years) were mostly attributed to attempted home treatment (45%) and other responsibilities (34%). After referral decision, 73% of caregivers brought their child to MRRH immediately. Delays in arrival (mean 33 days) were attributed to cost (17%) and transport (8%). Upon MRRH arrival, 57% of patients were assessed the same day, and time to surgery was short (0-97 days; median 1 day). Despite free under-5 health care, out-of-pocket payments were reported by 60% of patients (range, $1 – 40), equivalent to 1-40% of monthly household income.

Conclusion: Care-seeking delays are the most significant delay type in accessing pediatric surgical care in Uganda, and cost remains a barrier. Caregiver and primary provider education would be useful interventions in improving quality of care.

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Emergency pediatric surgery: comparing the economic burden in specialized vs non-specialized children’s centers

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2 Department of Pediatric Surgery, Providence Children’s Health. Portland, Oregon, USA
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Purpose: The American College of Surgeons, alongside the Task Force for Children’s Surgical Care, have developed a verification program for children’s surgery centers. Highly specialized hospitals may be verified as Level I, while those with fewer dedicated resources may be classified as Level II or Level III, respectively. Limited data exists on charge differences between more and less specialized hospitals. Our previous work in an adult emergency surgery population showed that specialized hospitals were more resource intensive. We hypothesized that more specialized children’s centers would utilize more resources.

Methods: We performed a retrospective study of the Maryland Health Services Cost Review Commission (HSCRC) database from 2009-2013, which includes all inpatient hospitalizations. We assessed total charge, length of stay (LOS), and charge per day for patients admitted with an emergency pediatric surgery diagnosis at each level hospital, controlling for severity of illness. Using published descriptions of resources, we assigned theoretical level designations to each hospital in Maryland.

Results: Two hospitals would qualify as Level 1 hospitals, with 4593 total emergency pediatric surgery admissions (38.5%) over the five-year study period. The greatest number of patients (4723, 39.5%) was treated at 14 Level II hospitals. Charges were significantly higher for children treated at Level I hospitals (all \(P<0.0001\), Table). Across all stages of severity of illness, children at Level I hospitals had significantly longer LOS (all \(P<0.0001\)).

Conclusion: Hospital charges and length of stay were higher at Level I pediatric centers, compared with Level II and Level III centers, regardless of severity of illness.
**Table: Total charges associated with hospitalization with EGS diagnosis**

<table>
<thead>
<tr>
<th>APR-SO1</th>
<th>Numb er</th>
<th>Charge</th>
<th>Numb er</th>
<th>Charge</th>
<th>Numb er</th>
<th>Charge</th>
<th>Numbe r</th>
<th>Charge</th>
<th>Kruskal -Wallis test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>19,942</td>
<td>7724</td>
<td>2626</td>
<td>6560</td>
<td>4723</td>
<td>6359</td>
<td>4593</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minor</td>
<td>4532</td>
<td>6149</td>
<td>1171</td>
<td>6224</td>
<td>2266</td>
<td>5680</td>
<td>1086</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>4547</td>
<td>7489</td>
<td>1254</td>
<td>6596</td>
<td>1948</td>
<td>6940</td>
<td>1345</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Major</td>
<td>1744</td>
<td>15,331</td>
<td>164</td>
<td>10,257</td>
<td>375</td>
<td>11,599</td>
<td>1205</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extreme</td>
<td>1128</td>
<td>42,202</td>
<td>37</td>
<td>23,260</td>
<td>134</td>
<td>24,119</td>
<td>957</td>
</tr>
</tbody>
</table>

*Median (IQR)*

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Racial disparity in an outreach pediatric surgical service: real or unreal?

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Purpose: Ethnic disparities in Maori and Pacific islanders receiving elective surgery are demonstrated across multiple areas of health care. The monthly outreach day surgery in a health board with high Maori community was selected to determine whether this disparity is seen.

Methods: All pediatric surgical procedures between May 2014 and May 2016 were included and the days from entry to waiting list to the day of surgery were calculated and compared with target times set by the Ministry of Health. The patient demographics were collated.

Results: Two hundred and three pediatric day surgeries were performed on 193 patients undergoing 42 different procedures. 192 (94.6%) met inclusion criteria and 28 (14.58%) breached maximum waiting time against 0% tolerance. Maori contributed to 64.29% (n=18) and New Zealand European were 25.0% (n=7). This is disproportionate to the ethnic mix in the area and the sample population (46% each) studied. A single primary surgeon prioritized the elective operations based on Clinical Priority Assessment Criteria and performed all surgeries reducing inconsistencies.

Conclusion: Two hundred and three pediatric day surgeries were performed on 193 patients undergoing 42 different procedures. Of them 192 (94.6%) met inclusion criteria and 28 (14.58%) breached maximum waiting time against 0% tolerance allowed by the ministry. Maori contributed to 64.29% (n=18) and New Zealand European were 25.0% (n=7). This is disproportionate to the ethnic mix in the area and the sample population (46% each) studied. A single primary surgeon prioritized the elective operations based on Clinical Priority Assessment Criteria (CPAC) and performed all surgeries reducing inconsistencies.

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Injury patterns of child abuse: experience of two level 1 pediatric trauma centers

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Purpose: This study examines non-accidental trauma (NAT) fatalities as a percentage of all injury fatalities and identifies injury patterns in NAT admissions to two level I pediatric trauma centers serving a population of over 480,000 children under the age of 5.

Methods: After IRB approval (H-39155), we reviewed all children (<5 years old) treated for NAT from 2011-2015. Patient demographics, injury severity score (ISS), injury locations and fatalities were obtained from each institutional trauma registry.

Results: Of 4,623 trauma admissions, 557 (12%) were due to NAT (69% <1 year old). NAT fatalities (n=42) comprised 45% of overall trauma fatalities (n=92). A larger proportion of total trauma deaths due to NAT was seen in children <1 year old (55% vs. 40%, p=0.20) compared to children ages 1-4. For NAT admissions, median ISS was 10 (IQR 5-17) although fatal cases had median ISS of 26 (IQR 18-30). The most common body region injured in NAT was the head (n=334, 60%) and included intracranial bleeding in 71% of patients. Extremity, thoracic, facial and abdominal injuries occurred in 183 (33%), 101(18%), 79 (14%), and 42 (8%) patients, respectively. Although 76% of head injuries occurred in infants <1 year, children ages 1-4 with head injuries had a significantly higher case fatality rate (27% vs. 6%, p<0.001). Head injuries increased the risk of death (RR 4.9, 95% CI 2.0-12.4).

Conclusion: We conclude that a disproportionately high number of trauma fatalities are due to child abuse in children under 5 years old. Intracranial injuries are common in child abuse and increase the risk of death substantially.

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Experience with peritoneal thermal injury during subcutaneous endoscopically assisted ligation for pediatric inguinal hernia

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Purpose: Subcutaneous endoscopically-assisted ligation (SEAL) for pediatric inguinal hernia has gained in popularity although variations in techniques exist. Peritoneal scarring by thermal injury has been described as an adjunct. We sought to explore the hypothesized inverse-correlation between peritoneal scarring and recurrence after SEAL.

Methods: We conducted a single-centre retrospective review of all patients < 18 years-old undergoing SEAL between 2010-2016 (REB-20172727). Demographics and outcomes were investigated. Univariate and multi-variable logistic-regression was performed to evaluate whether peritoneal scarring or other potential variables predict recurrence.

Results: We identified 252 patients. Median age was 3 years-old, 35% were female, and 18% had a history of prematurity. Median follow-up was 26 months; ≥1 visit/patient. Bilaterality was noted in 35%. There were no reported cases of metachronous hernia, vas injury, testicular atrophy or chronic pain. The recurrence rate was 4%. Institutional experience, incarceration, and suture type (Ti-Cron vs. Ethibond) had significant correlation with recurrence on univariate analysis (p<0.25); surgeon experience did not. Peritoneal scarring, performed in 188 cases (75%), was not predictive of recurrence (adjusted OR=1.28, p=0.761) on multi-variable analysis, see Table 1.

Conclusion: The overall rate of complications with SEAL compares favorably to published data. Thermal injury was not associated with an improvement in recurrence rate. Further research is needed to conclude definitively whether the benefits of peritoneal scarring outweigh any risks.
### Table 1. Results of Multi-Variable Logistic Regression Exploring Predictors of Recurrence after Subcutaneous Endoscopically-Assisted Ligation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Recurrence (N=12)</th>
<th>No recurrence (N=223)</th>
<th>Adjusted OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), median (range)</td>
<td>2.5 (0,17)</td>
<td>3 (0,18)</td>
<td>1.04 (0.88, 1.20)</td>
<td>0.636</td>
</tr>
<tr>
<td>Prematurity</td>
<td>4 (33%)</td>
<td>42 (18%)</td>
<td>3.47 (0.64, 16.8)</td>
<td>0.130</td>
</tr>
<tr>
<td>Presence of comorbidities</td>
<td>2 (17%)</td>
<td>62 (26%)</td>
<td>0.35 (0.04, 1.80)</td>
<td>0.248</td>
</tr>
<tr>
<td>Institutional experience (cases to date), median (range)</td>
<td>82 (4, 228)</td>
<td>130 (1, 252)</td>
<td>0.99 (0.98, 1.00)</td>
<td>0.139</td>
</tr>
<tr>
<td>Presence of fellow</td>
<td>11 (92%)</td>
<td>178 (74%)</td>
<td>2.84 (0.47, 54.9)</td>
<td>0.341</td>
</tr>
<tr>
<td>Incarceration</td>
<td>3 (25%)</td>
<td>18 (8%)</td>
<td>7.81 (0.62, 75.8)</td>
<td>0.087</td>
</tr>
<tr>
<td>Suture type (Ti-Cron vs. Ethibond)</td>
<td>1 (8%)</td>
<td>2 (1%)</td>
<td>6.81 (0.27, 89.9)</td>
<td>0.156</td>
</tr>
<tr>
<td>Peritoneal thermal injury</td>
<td>8 (66%)</td>
<td>180 (75%)</td>
<td>1.30 (0.26, 7.44)</td>
<td>0.756</td>
</tr>
</tbody>
</table>

1. OR = Odds Ratio  
2. CI = Confidence Interval  
3. p-value < 0.05 was considered significant

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Parental presence at induction of anesthesia: parent and health professional evaluation of a new program

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Purpose: Parental presence at induction of anesthesia (PPI) may help decrease patient and parental anxiety associated with the perioperative experience, and enhance satisfaction with care. In this particular study, we analyzed the outcomes of a new PPI program initiated at our hospital in 2011.

Methods: Participants in the PPI program received a preoperative training session, and parents subsequently accompanied the child to the operating theatre, with or without a Child Life Specialist (CLS). A Likert scale satisfaction survey was sent to anesthesiologists, respiratory therapists, post anesthesia care unit (PACU) nurses, and parents who participated in PPI during a six-month period in 2015.

Results: Response rates were as follows: Parents (73/169, 43.2%), anesthesiologists (8/18, 44.4%), PACU nurses (9/17, 52.9%), respiratory therapists (7/14, 50%). More than 90% of parents, anesthesiologists, and PACU nurses felt that PPI significantly decreased anxiety for both parents and patients, improved cooperation, and facilitated induction of anesthesia. Other prominent results are shown in the table. Improvements to the program were suggested through increased funding, accessibility, and teaching of anxiolytic coping skill for parents.

Conclusion: Parents express extremely high satisfaction with PPI. The majority of healthcare professionals identify PPI as a valuable perioperative intervention.

Table. Percentage of participants agreeing with these statements

<table>
<thead>
<tr>
<th>Participant</th>
<th>n</th>
<th>Parental presence beneficial</th>
<th>CLS presence beneficial</th>
<th>Parents remained calm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents</td>
<td>73</td>
<td>67 (91.8%)</td>
<td>70 (95.9%)</td>
<td>70 (95.9%)</td>
</tr>
<tr>
<td>Anesthesiologists</td>
<td>8</td>
<td>5 (62.5%)</td>
<td>8 (100.0%)</td>
<td>7 (87.5%)</td>
</tr>
<tr>
<td>PACU Nurses</td>
<td>9</td>
<td>8 (88.8%)</td>
<td>6 (66.6%)</td>
<td>8 (88.8%)</td>
</tr>
<tr>
<td>Respiratory Therapists</td>
<td>7</td>
<td>5 (71.4%)</td>
<td>3 (42.9%)</td>
<td>4 (57.1%)</td>
</tr>
</tbody>
</table>

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Sclerotherapy for intramuscular vascular malformations: a single center experience

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Purpose: Vascular malformations isolated to skeletal muscles are rare and challenging to treat. Multi-modal management including compression garments, medical therapy, surgical debulking, and sclerotherapy. Purpose is to determine the efficacy of sclerotherapy on isolated intramuscular vascular malformations (IVM).

Methods: Retrospective institutional review of patients between 2008-2016 who underwent sclerotherapy for IVM. Demographics, indications, and clinical follow-up were analyzed.

Results: A total of 300 patients underwent sclerotherapy of which 20 had IVM. 6 male and 14 female underwent 58 procedures. All patients presented with pain and were treated with compression garments prior to intervention. The median age at first treatment was 13 years (+/- 5.06 years). Initial treatment protocol consisted of 2 sclerotherapy procedures with sodium tetradecyl sulfate (STS) within a 2-3 month interval. Median volume of the lesion was 40 cm³ (+/- 28.7), most were located in the lower extremity (15/20). Median number of treatments was 2 (+/- 1.95). Treatment prior to puberty resulted in a median symptom free time of 4 years (+/- 2.18) while after puberty resulted in a symptom free time of 2 years (+/- 2.28). 2 patients had coagulopathy and were admitted for observation and peri-procedural Lovenox. No procedure related complications were recorded with a follow-up of median 4 years (+/- 2.27).

Conclusion: IVMs are rare but debilitating due to pain. Sclerotherapy is a useful minimally invasive procedure generally requiring at least two consecutive treatments for success. Treatment of patients prior to puberty appears to provide a more durable treatment and surgical resection which can be debilitating can be avoided.

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Unmet burden of pediatric surgical disease, delayed access to surgery, and surgical backlog in Africa

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Purpose: The purpose of this study was to estimate the unmet burden of surgically correctable congenital anomalies in African low- and middle-income countries (LMICs).

Methods: We conducted a chart review of children operated for cryptorchidism, isolated cleft lip, hypospadias, bladder exstrophy and anorectal malformation at an Ethiopian referral hospital between January 2012 – July 2016 and a scoping review of the literature describing the management of congenital anomalies in African LMICs. Procedure numbers and age at surgery were collected to estimate mean surgical delays by country and extrapolate surgical backlog. The unmet surgical need was derived from incidence-based disease estimates, established disability weights, and actual surgical volumes.

Results: The chart review yielded 210 procedures in 207 patients from Ethiopia. The scoping review generated 42 data sets, extracted from 36 publications, encompassing: Benin, Egypt, Ghana, Ivory Coast, Kenya, Nigeria, Madagascar, Malawi, Togo, Uganda, Zambia, and Zimbabwe. Findings were stratified by congenital anomaly and are detailed in the attached table. The largest national surgical backlog was noted in Nigeria for cryptorchidism (209,260 cases) and cleft lip (4,154 cases), and Ethiopia for hypospadias (20,188 cases), bladder exstrophy (575 cases) and anorectal malformation (1,349 cases).

Conclusion: This data supports the need for upscaling pediatric surgical capacity in LMICs to address the significant surgical delay, surgical backlog, and unmet prevalent need.

<table>
<thead>
<tr>
<th></th>
<th>Mean Surgical Delay (years)</th>
<th>Overall Surgical Backlog (cases)</th>
<th>Overall Unmet Prevalent Need (DALYs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptorchidism</td>
<td>2.71</td>
<td>320,777</td>
<td>242,761</td>
</tr>
<tr>
<td>Cleft Lip</td>
<td>2.23</td>
<td>6,300</td>
<td>4,686</td>
</tr>
<tr>
<td>Hypospadias</td>
<td>2.78</td>
<td>59,181</td>
<td>7,102</td>
</tr>
<tr>
<td>Bladder Exstrophy</td>
<td>2.19</td>
<td>685</td>
<td>2,979</td>
</tr>
<tr>
<td>Anorectal Malformation</td>
<td>0.79</td>
<td>2,001</td>
<td>1,026</td>
</tr>
</tbody>
</table>

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Surgical outcomes of patients with Beckwith-Wiedemann syndrome

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Purpose: To evaluate treatment and surgical outcomes of patients of Beckwith-Wiedemann syndrome (BWS) treated at a tertiary children’s hospital.

Methods: IRB approved (H-39759). Retrospective review of infants evaluated at our institution for BWS from August 2005 to December 2016. Data collected includes demographic information, clinical presentation, genetic and pathologic evaluation, fetal imaging, operative treatment, and outcomes.

Results: Forty-seven children with a diagnosis of BWS were identified. Sixty-four percent (n=30) had a genetic mutation in an imprinting domain of chromosome 11p15. All infants had two to five of the major syndromic features (macrosomia, macroglossia, hyperinsulinism, abdominal wall defect, or hemihypertrophy). Thirty-two patients (68%) underwent at least one operation related to BWS with a median of 2 [range: 0-8] surgical procedures per patient. Sixteen underwent omphalocele repair, partial glossectomy -12, surgeries related to hemihypertrophy -7, and 6 had resection of an embryonal tumor (adrenal cortical adenomas -2, Wilms’ tumor -1, hepatoblastoma -1, and hemangioblastoma -1). One patient required 95% pancreatectomy for hyperinsulinism. Identification of a genetic mutation was not associated with the need for surgical intervention (59%, p=0.52). Presence of an omphalocele and macroglossia also was associated with an earlier age of diagnosis of BWS, (median 0.7 and 1.25 months, respectively). Overall, survival was 100% with difficult feeding (50%) being the most frequent post-surgical complication.

Conclusion: In conclusion, a substantial number of patients with Beckwith-Wiedemann Syndrome will require surgery, particularly those with an abdominal wall defect or macroglossia. However, surgery in this population does not correspond to poor outcomes which are similar to those exhibiting mostly non-surgical features of BWS.

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Intestinal malrotation in infants with omphalocele: a systematic review and meta-analysis

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Purpose: To determine whether infants with omphalocele should be investigated and treated for intestinal malrotation (IM).

Methods: Using a defined search strategy, two investigators independently identified all studies reporting infants with omphalocele and associated IM. Case reports and opinion articles were excluded. As all infants with a diagnosis of IM underwent a Ladd’s procedure, we compared these patients (Ladd’s group) with those who had not been investigated or without IM (controls). The meta-analysis was conducted according to PRISMA guidelines and using RevMan 5.3.

Results: Of 5,361 titles/abstracts screened, 110 full-text articles were analyzed. Thirteen studies (3,205 children) reported presence of IM in 106 omphalocele (3.3%). However, when IM was actively sought, its incidence was 13.9%. Furthermore, IM was as frequent in major (≥5cm, 15.2%) as in minor omphalocele (<5cm, 13.6%; p=ns). Post-operatively, the incidence of adhesive bowel obstruction was similar between patients who underwent Ladd’s procedure (5.3%) and those who did not (3.9%; p=ns). Likewise, the incidence of post-operative volvulus was similar in Ladd’s group (4.2%) and in controls (3.2%; p=ns, Figure).

Conclusion: The incidence of IM in infants with omphalocele is low but probably under-reported, and is not influenced by the size of the defect. At present, there is no evidence in the literature to support investigations to detect IM in infants with omphalocele.
Protocol development and preliminary outcomes of utilizing technology in adolescent bariatric surgery patients

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Purpose: As the number of bariatric procedures in adolescents continues to increase, providers have to find ways to keep patients engaged in treatment. This, in turn, increases the likelihood of making sustained necessary behavioral changes. Literature on the use of technology has boomed; however, no research to date has examined its use in adolescent bariatric surgery programs. This study examines the feasibility and acceptability of three technology interventions.

Methods: A convenience sample of all preoperative adolescents undergoing bariatric surgery was used. Institutional Review Board (IRB) approval was obtained. Three interventions – Facebook, text messaging and Skype support groups – were selected. Families chose to participate in one, two or all three interventions and were interviewed every six months regarding its feasibility and acceptability. This abstract reviewed the data from the first eight families who participated in this study.

Results: All families elected to participate in the text messaging arm, 2 in Facebook and 4 in the Skype support groups and none have dropped out of the program. All families found the interventions to be feasible and acceptable. They felt the information was motivational and that the use of the technology was not intrusive.

Conclusion: Preliminary evidence suggests that technological interventions are feasible and accepted by adolescents participating in a bariatric surgery program. Further research should continue to examine the role of technology to provide ongoing support for those undergoing bariatric surgery and other surgical procedures.

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Introduction of a geographic information system (GIS)-enabled trauma registry and health records strengthening at a Uganda hospital

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2 Mbarara University of Science and Technology, Mbarara, Uganda

Purpose: Trauma data collection, especially for injured children, is very limited in Low and Middle Income Countries (LMIC). This study examines the feasibility of implementing a GIS-enabled trauma registry for pediatric and adult patients at Mbarara Regional Referral Hospital (MRRH) in Uganda, as a pilot towards the development of a national injury surveillance system.

Methods: A minimum dataset trauma registry tool was developed by reviewing LMIC trauma literature and modified through stakeholder input from MRRH. A workflow assessment was conducted to determine the current and potential data collection points and understand medical records infrastructure and processes. The tool was evaluated against retrospectively collected records to identify gaps in current trauma data collection. Prospective data collection of all consecutive trauma presentations to the emergency department at MRRH then began.

Results: The pilot revealed expansive gaps in medical records, including patient identification numbers and vital sign capture. Within the first month of implementation, 103 patients were prospectively enrolled into the pilot registry. Of these, 28 patients were pediatric (54% male). The average age of pediatric patients was 7 years (±6), with ages ranging from 2 months to 18 years. Mechanisms of injury included traffic accidents (12), unintentional falls (3), burns (8), stabs (4), and animal bite (1). 16 patients (57%) were admitted to the hospital, of which 2 died before discharge.

Conclusion: This demonstrates the feasibility of introducing a pilot trauma registry tool, sheds light on the burden of pediatric trauma and showcases the need to strengthen medical records systems at this Uganda hospital.

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Qualitative review of pediatric surgical checklists in clinical practice

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Purpose: Since the World Health Organization (WHO) surgical safety checklist (SSC) was launched in 2009, checklists have been integrated into diverse surgical systems worldwide. Building upon our systematic review of pediatric SSC use, we aim to assess how current pediatric checklists address pediatric-specific needs.

Methods: We identified 7 studies from our systematic review that included a copy of their pediatric SSCs. We also collected pediatric SSCs from 11 Canadian hospitals. We categorized modifications of checklists and compared these to the original WHO SSC.

Results: Most checklists (15/18) varied little from the WHO SSC with three phases (briefing, time out, and debriefing). Few SSCs were specifically adapted for pediatric surgery. Between 95-100% of checklists included the following elements: briefing (patient and procedure identification, allergies); time out (antibiotic prophylaxis, concerns before proceeding); and debriefing (sponge/needle count, specimens). Elements rarely addressed included: NPO status and ASA class. Checklists that were modified to meet the needs of pediatric patients included parents in the checklist, and addressed patient weight and hypothermia risk. Center-specific modifications included simplification for simple cases, and initiation of the huddle at the start of the day. The core elements of Canadian checklists were similar to those in published literature with modifications primarily to meet institutional needs.

Conclusion: Current pediatric checklists share significant commonalities with the WHO SSC. An opportunity exists to address pediatric-specific needs in addition to center-specific needs within SSCs. Customization of pediatric checklists is vital to further improve communication and teamwork in pediatric surgical care.

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Maternal substance use and mortality rates in children with gastroschisis

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Purpose: Each year over 100 children are born in Canada with gastroschisis (GS). No studies to date have examined the relationship between maternal substance use (tobacco, alcohol, narcotics or marijuana) during pregnancy and mortality in these children. We hypothesized that maternal substance use is associated with higher mortality in children with GS.

Methods: We performed a case-control study among all children managed for GS between 1991 and 2016 at our site. This data was extracted from our clinical database which includes all children treated for a congenital surgical anomaly over this time period. The GS patients were separated into two groups based on maternal self-reported substance use during pregnancy. The mortality rates were then compared using a Fisher’s exact test.

Results: The mortality rate of the 152 children with GS was 8.6%. Of the 152 children, 78 mothers reported substance use, 56 reported no substance use, and 18 were unknown. The mortality rate of GS children whose mothers reported substance use was approximately 7fold higher than those who did not (14.1% vs 1.79%, p=0.014). Despite the difference in mortality rates, there were no differences in GS properties (atresia, ischemia, perforation, matting organs herniated), co-morbidities or maternal age.

Conclusion: To our knowledge, this is the first report that associates maternal substance use with increased mortality in children with GS. Importantly, the mortality rates were independent of GS properties, co-morbidities and maternal age. These observations need to be confirmed using a larger, nationally representative sample of children with GS.

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Intestinal ischemia in paediatric patients with ventricular assist devices

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3 Stollery Children's Hospital, Edmonton, Alberta, Canada

Purpose: Ventricular Assist Devices (VADs) have made a great impact on heart failure therapy. Non-cardiac ischemic events are a known complication from VADs. While these are readily identifiable in adults due to the access to Computed Tomography scans, there is yet to be such success in the paediatric population. This study aims to describe the challenge in diagnosing intestinal ischemia secondary to VADs in paediatric patients.

Methods: A chart review of all patients receiving VADs from 2005-2015 was performed using the Stollery Children’s Hospital Artificial Heart Program database. Patients diagnosed with intestinal ischemia were assessed for diagnostic workup and timeline to intervention.

Results: Four of 54 patients developed intestinal ischemia. They were 3 days, 42 days, 2.8 years and 17 years old at the time of VAD implant. Ischemia occurred 1.5 to 4 months post-implant. One patient was successfully treated nonoperatively. Three patients had intraoperative findings more severe than identified on clinical assessment and imaging. Two patients had global splanchnic ischemia leading to death. One patient had a malrotation leading to jejunal resection secondary to multiple perforations.

Conclusion: The interpretation of clinical and imaging findings is difficult in the setting of VAD implants. Extensive ischemia was identified intraoperatively despite adequate preoperative workup. A high index of suspicion is required for intestinal ischemia in paediatric patients with VADs. Early consultation with Paediatric Surgery should be considered when there is suspicion of ischemia and ongoing follow-up by the same surgeon to detect subtle clinical changes. Further work is required to identify markers of early intestinal compromise.

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Anticoagulation results in increased line salvage for children with intestinal failure and central venous thrombosis

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5 Division of Pediatric Surgery, University of Texas Southwestern/Children's Health, Dallas, Texas, USA

Purpose: The purpose of this study was to investigate whether anticoagulation (AC) is beneficial for line salvage in children with intestinal failure (IF) and catheter-associated central venous thrombosis (CVT), who continue to require central venous access.

Methods: A retrospective, single institution review of 19 parenteral nutrition dependent children with IF and known CVT from 2006-2017 was performed. Frequencies of catheter-related complications including infection, occlusion, and breakage were compared 18 months prior to and after AC. Data were analyzed using Poisson regression. P-values < 0.05 were considered significant.

Results: Nineteen children had one or more CVT, with the subclavian vein most commonly thrombosed (63%). Low molecular weight heparin was used for AC in all cases and six patients (32%) had clot resolution on repeat imaging while receiving AC. Mean catheter-related bloodstream infections decreased from 7.9 to 4.4 per 1000 catheter days during AC (p=0.01), and the number requiring catheter replacement decreased from 3.0 to 1.0 (p=0.01), per 1000 catheter days. There were no statistically significant differences in line occlusions or breakages when comparing 18 months before and after AC (Figure 1).

Conclusion: Anticoagulation for children with intestinal failure and central venous thrombosis may prevent thrombus propagation, decrease bloodstream infections and line replacements. Further research is needed to determine optimal dosing and duration of therapy.
Figure 1: Catheter-related complications before and after initiation of anticoagulation

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Stapled versus hand-sewn pediatric bowel anastomoses: a retrospective cohort study

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² British Columbia Children's Hospital, Vancouver, British Columbia, Canada

Purpose: The choice of intestinal anastomotic technique remains inadequately investigated in the pediatric population. The risk of anastomotic stricture is a significant concern with stapled anastomosis. The purpose of this study is to compare the early outcomes of both techniques.

Methods: All patients undergoing intestinal anastomosis at a single academic centre from 2014-2016 were included. A hand-sewn anastomosis (HA) group was compared with a stapled anastomosis (SA) group with regards to baseline characteristics and early post-operative complications. Primary outcomes were incidence of anastomotic complications, including leak and stricture formation.

Results: We analyzed 96 patients that underwent 116 intestinal anastomoses (78 HA and 38 SA). Both groups were similar in their baseline characteristics. The median age was 10.6 months in the HA group versus 65.8 months in the SA group. The overall anastomotic leak rate was 2.6% with no difference between both groups. Despite an overall stricture rate of 12%, there was no significant difference between the two groups (11.7% in the HA group versus 13.2% in the SA group). Other less frequent complications were also similar between both groups, including postoperative bowel obstruction, enterocutaneous fistula, and intra-abdominal abscess.

Conclusion: We conclude that both hand-sewn and stapled anastomotic techniques have similar anastomotic complication rates in the pediatric population.

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Transient post-operative polyuric syndrome after colo-rectal surgery in newborn and young infants

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Purpose: Colo-rectal surgery may influence water balance, in particular in newborn and young infants with immature renal function. However, little is known about the impact of colo-rectal surgery on water balance in these patients. Our aim was to evaluate diuresis patterns in neonates and young infants after major colo-rectal surgery.

Methods: Retrospective review of all patients admitted (2011–2016) for Hirschsprung disease (HD) and anorectal malformation (ARM). Intraoperative fluids followed a defined protocol (5-8 ml/kg/hr). Data considered: age at surgery, pre- and post-operative weight, pre- and post-operative urine output, prevalence of polyuria (>4ml/kg/h for at least 24 hours) and its duration. Results are median (95% CI or prevalence). Mann-Whitney or X2 test were used.

Results: During the period, 115 patients underwent major colo-rectal surgery: 58 ARM and 57 HD. Post-operative urine output was 5.8 ml/kg/hr (4.5-6.8) (p<0.0001 vs pre-operative urine output in both HD and ARM). Table shows main results.

Conclusion: Colorectal surgery is associated with water balance derangements, apparently more profound (but lasting less) in HD patients. Further studies are needed to define if metabolic and/or renal factors play a role in these abnormalities.

<table>
<thead>
<tr>
<th></th>
<th>HD</th>
<th>ARM</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op weight (kg)</td>
<td>3.9 (3.4-5.5)</td>
<td>4.6 (3.8-5.1)</td>
<td>0.3759</td>
</tr>
<tr>
<td>Post-op weight (kg)</td>
<td>4.0 (3.5-5.5)</td>
<td>4.7 (3.7-5.2)</td>
<td>0.3694</td>
</tr>
<tr>
<td>Delta weight (g)</td>
<td>+32.5 (-38.5 - +80)</td>
<td>+49 (+10 - +106)</td>
<td>0.0731</td>
</tr>
<tr>
<td>Age (days)</td>
<td>60 (9-5060)</td>
<td>69 (2-1085)</td>
<td>0.4354</td>
</tr>
<tr>
<td>Pre-op urine output (ml/kg/hr)</td>
<td>3.6 (3.1-4.2)</td>
<td>3.5 (2.8-4.0)</td>
<td>0.3653</td>
</tr>
<tr>
<td>Post-op urine output (ml/kg/hr)</td>
<td>6.8 (5.6-7.3)</td>
<td>5.2 (4.1-6.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Polyuria (%)</td>
<td>96.5</td>
<td>74.4</td>
<td>0.0006</td>
</tr>
<tr>
<td>Duration of polyuria (days)</td>
<td>2.0 (1.0-4.0)</td>
<td>5.0 (3.0-8.0)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Neonatal one-stage pull-through for Hirschsprung’s disease: a systematic review and meta-analysis

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Purpose: To compare the safety and efficacy of definitive one-stage surgery for Hirschsprung’s disease in the neonatal period versus after the neonatal period.

Methods: We conducted a literature search of Central, Medline, Embase, and Cinahl up to January 2017 and hand-searched the references of included articles to identify studies on one-stage surgical repair of Hirschsprung’s disease that compared surgery in neonates versus older children. Two authors screened articles for inclusion independently with consensus. One author extracted data and other checked it for accuracy. We conducted meta-analyses when possible, using the random-effects model, to calculate mean differences with 95% confidence intervals.

Results: We identified 6 relevant studies, one of which was prospective; we did not identify any randomized controlled trials. Operative time was significantly shorter in neonates compared to non-neonates (3 studies, mean difference -13.46, 95% confidence interval -20.32 to -6.59, P = 0.0001); however, postoperative hospital stay was significantly shorter in non-neonates (2 studies, mean difference 1.41, 95% confidence interval 0.29 to 2.52, P = 0.01). There were no significant differences between groups in operative blood loss (% blood volume), need for blood transfusion, postoperative enterocolitis, wound infection, surgery-related death, peri-operative complications overall, or bowel function on follow-up. One study found that the time to normal stooling after surgery was longer for neonates.

Conclusion: We conclude that, based on the limited evidence available, one-stage pull-through for Hirschsprung’s disease appears feasible in neonates, although the recovery period may be longer. Larger, prospective comparative studies would be beneficial to confirm these findings.

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Necrotizing enterocolitis in patients with congenital heart disease: a single center experience

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² Texas Childrens Hospital, Department of Pediatrics, Divisions of Cardiology. Baylor College of Medicine, Houston, Texas, USA
³ Texas Childrens Hospital, Department of Pediatrics, Divisions of Neonatology, Baylor College of Medicine, Houston, Texas, USA

Purpose: To evaluate the characteristics of patients with congenital heart disease (CHD) that developed necrotizing enterocolitis (NEC).

Methods: Retrospective review of neonates with CHD at a tertiary care center between 2006 and 2015 (IRB-H34662). Diagnosis of NEC was based on modified Bell’s criteria. Patients were grouped by Risk Adjustment for Congenital Heart Surgery (RACHS-1) or by ductal-dependent (DD) lesions that require a patent ductus arteriosus to supply pulmonary or systemic circulation.

Results: Of 1811 neonates with CHD, 3.4% (n=61) developed NEC. Eighteen (30%) of these required surgical management. The rate of NEC among DD patients was 5% (n=33/653), compared to 2.4% (n=28/1158) in the non-DD group (p=0.003). RACHS-1 score >2 had a higher rate of NEC 6.1% (40/658) compared to RACHS ≤2 cases, 1.8% (21/1153) (p=0.005). Hypoplastic left heart syndrome (HLHS) patients had a NEC rate of 9% (n=16/185). DD patients and complex patients with RACHS-1 score >2 were more likely to develop NEC after cardiac surgery (Table 1). Interestingly, surgical NEC was more prevalent in the non-DD group. Mortality was similar among groups.

Conclusion: CHD patients with DD lesions or complex cases (RACHS-1 score >2) have higher rates of NEC than non-DD patients or RACHS-1 score of 2 or less. Mortality is similar regardless of ductal dependence but surgical NEC was more prevalent in non-DD patients.
Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Non-Ductal Dependent (n=28)</th>
<th>Ductal Dependent (n=33)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational age (weeks)</td>
<td>27±8.5</td>
<td>36±2.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Birth weight (grams)</td>
<td>1178±737</td>
<td>2399±722</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age at NEC diagnosis (days)</td>
<td>22±12</td>
<td>37±42</td>
<td>0.18</td>
</tr>
<tr>
<td>NEC after cardiac surgery (n)</td>
<td>21%(6)</td>
<td>45%(15)</td>
<td>0.04</td>
</tr>
<tr>
<td>Bypass time (minutes)</td>
<td></td>
<td>212±94</td>
<td></td>
</tr>
<tr>
<td>Aortic Clamp time (minutes)</td>
<td>26</td>
<td>106±81</td>
<td>0.3</td>
</tr>
<tr>
<td>Surgical NEC (n)</td>
<td>39%(11)</td>
<td>21%(7)</td>
<td>0.1</td>
</tr>
<tr>
<td>Mortality (n)</td>
<td>36%(10)</td>
<td>21%(7)</td>
<td>0.1</td>
</tr>
</tbody>
</table>

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Primary anastomosis versus enterostomy for infants with necrotizing enterocolitis: a systematic review and meta-analysis

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Purpose: Standard surgical treatment for the patients with necrotizing enterocolitis (NEC) is still controversial. There are two surgical options after resecting necrotic of perforated bowel, such as forming an enterostomy and primary anastomosis. However, there is a lack of good evidence of preferred surgical treatment. The aim of this study is to compare primary anastomosis with enterostomy.

Methods: We performed a systematic review and meta-analysis. We searched Medline and EMBASE from inception for comparative studies between primary anastomosis and enterostomy in the patients with NEC. Primary outcome was mortality and complication rate.

Results: We identified 11 observational studies which included 334 patients with enterostomy and 258 patients with primary anastomosis. There was no randomized control trial. Mortality rate was significantly higher in enterostomy group compared to primary anastomosis (Odds ratio = 2.97; 95%CI = 1.40-6.27; P<0.01) (Figure A). There was no significant difference in complication rate between primary anastomosis and enterostomy (Odds ratio = 1.28; 95%CI = 0.60-2.71; p=0.52) (Figure B).

Conclusion: Mortality rate was significantly lower in primary anastomosis. However, selection bias cannot be excluded on the basis of the studies analyzed. The results of this study indicate that primary anastomosis can be considered in infants with NEC. A randomized control trial is necessary to evaluate if primary anastomosis is safer than enterostomy.
A. Forest plot for mortality

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Enterostomy Events</th>
<th>Total</th>
<th>Anastomosis Events</th>
<th>Total</th>
<th>Weight</th>
<th>M-H, Random, 95% CI</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kristeller 1979</td>
<td>22</td>
<td>45</td>
<td>1</td>
<td>9</td>
<td>6.7%</td>
<td>0.03 [0.08, 0.30]</td>
<td>1979</td>
</tr>
<tr>
<td>Pelzett 1980</td>
<td>11</td>
<td>26</td>
<td>2</td>
<td>20</td>
<td>9.5%</td>
<td>0.00 [0.00, 0.00]</td>
<td>1980</td>
</tr>
<tr>
<td>Sparrow 1987</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>10</td>
<td>7.2%</td>
<td>0.17 [0.23, 1.14]</td>
<td>1987</td>
</tr>
<tr>
<td>Cooper 1988</td>
<td>33</td>
<td>116</td>
<td>14</td>
<td>27</td>
<td>12.6%</td>
<td>0.07 [0.06, 0.08]</td>
<td>1988</td>
</tr>
<tr>
<td>Griffiths 1993</td>
<td>9</td>
<td>13</td>
<td>7</td>
<td>20</td>
<td>6.5%</td>
<td>0.19 [0.09, 0.38]</td>
<td>1993</td>
</tr>
<tr>
<td>Parigi 1994</td>
<td>6</td>
<td>17</td>
<td>0</td>
<td>6</td>
<td>4.3%</td>
<td>1.55 [0.80, 3.03]</td>
<td>1994</td>
</tr>
<tr>
<td>Faupl 1999</td>
<td>11</td>
<td>27</td>
<td>6</td>
<td>44</td>
<td>11.1%</td>
<td>1.05 [0.77, 1.43]</td>
<td>1999</td>
</tr>
<tr>
<td>Hotton 2004</td>
<td>9</td>
<td>29</td>
<td>6</td>
<td>34</td>
<td>11.0%</td>
<td>1.05 [0.84, 1.32]</td>
<td>2004</td>
</tr>
<tr>
<td>Hall 2005</td>
<td>8</td>
<td>14</td>
<td>4</td>
<td>12</td>
<td>8.9%</td>
<td>2.67 [1.04, 6.81]</td>
<td>2005</td>
</tr>
<tr>
<td>Singh 2006</td>
<td>11</td>
<td>26</td>
<td>11</td>
<td>37</td>
<td>11.7%</td>
<td>1.03 [0.94, 1.13]</td>
<td>2006</td>
</tr>
<tr>
<td>Eiffert 2010</td>
<td>9</td>
<td>11</td>
<td>2</td>
<td>12</td>
<td>6.7%</td>
<td>2.30 [0.60, 8.93]</td>
<td>2010</td>
</tr>
</tbody>
</table>

Total (95% CI): 334/258 = 100.0% 2.07 [1.40, 6.27]

Total events: 131/57
Heterogeneity: Tau² = 0.07; Chi² = 28.70; P = 0.001; I² = 66%
Test for overall effect Z = 2.65 (P = 0.004)
Favours enterostomy vs. Favours Anastomosis

B. Forest plot for complications

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Enterostomy Events</th>
<th>Total</th>
<th>Anastomosis Events</th>
<th>Total</th>
<th>Weight</th>
<th>M-H, Random, 95% CI</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sparrow 1987</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>10</td>
<td>16.4%</td>
<td>1.75 [0.22, 13.10]</td>
<td>1987</td>
</tr>
<tr>
<td>Griffiths 1993</td>
<td>3</td>
<td>13</td>
<td>4</td>
<td>29</td>
<td>13.7%</td>
<td>1.60 [0.35, 7.03]</td>
<td>1993</td>
</tr>
<tr>
<td>Parigi 1994</td>
<td>4</td>
<td>17</td>
<td>3</td>
<td>6</td>
<td>16.9%</td>
<td>0.28 [0.04, 1.77]</td>
<td>1994</td>
</tr>
<tr>
<td>Hoffman 2004</td>
<td>7</td>
<td>26</td>
<td>12</td>
<td>34</td>
<td>22.0%</td>
<td>0.95 [0.59, 1.50]</td>
<td>2004</td>
</tr>
<tr>
<td>Hall 2005</td>
<td>8</td>
<td>14</td>
<td>1</td>
<td>12</td>
<td>6.5%</td>
<td>1.47 [0.69, 3.13]</td>
<td>2005</td>
</tr>
<tr>
<td>Singh 2006</td>
<td>10</td>
<td>26</td>
<td>13</td>
<td>37</td>
<td>22.5%</td>
<td>1.32 [0.71, 2.44]</td>
<td>2006</td>
</tr>
<tr>
<td>Eiffert 2010</td>
<td>4</td>
<td>11</td>
<td>2</td>
<td>12</td>
<td>16.9%</td>
<td>3.08 [2.14, 4.71]</td>
<td>2010</td>
</tr>
</tbody>
</table>

Total (95% CI): 119/140 = 100.0% 1.28 [0.60, 3.31]

Total events: 30/38
Heterogeneity: Tau² = 0.39; Chi² = 8.34; P = 0.016; I² = 56%
Test for overall effect Z = 2.04 (P = 0.04)
Favours enterostomy vs. Favours Anastomosis

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Surgical outcomes in Alagille syndrome and PFIC: a single institution's 20-year experience

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Purpose: Alagille Syndrome (AGS) and Progressive Familial Intrahepatic Cholestasis (PFIC) are rare pediatric biliary disorders that lead to progressive liver disease. This study reviews our experience with the surgical management of these disorders over the last 20 years.

Methods: After IRB approval (H-38987), we retrospectively reviewed children diagnosed with AGS or PFIC (January 1996-December 2016) at a tertiary-care pediatric hospital. Data collected included demographics, diagnosis, surgical intervention (liver transplant or biliary diversion), and complications.

Results: Of 37 patients identified, 17 patients (8 AGS, 9 PFIC) underwent surgical intervention. Mean post-surgical follow-up was 6.9±4.7 years. Three patients underwent an initial diversion procedure, one external and two internal (gallbladder to colon). Two patients who underwent a hepatoportoenterostomy were subsequently shown to have Alagille Syndrome. Fourteen patients underwent liver transplantation. The three patients who underwent diversion were 3.1 years (AGS), 2.4 (PFIC1) and 3.2 (PFIC2) at the time of their surgery. PFIC patients tended to be older at the time of liver transplant compared to AGS (4.3±3.9 years vs. 2.4±1.1 years, p=0.25). The AGS patient with partial external biliary diversion (PEBD) had resolution of symptoms and no complications (follow-up: 12.5 years). Both PFIC patients with partial internal biliary diversion (PIBD) had some diarrhea (6-8 stools/day) with resolution of pruritus and no progression of liver disease (follow-up: 3.8 and 4.5 years).

Conclusion: Patients with AGS and PFIC may benefit from diversion for symptomatic control and potential improvement in the progression of liver disease. Patients who present with significant hepatocellular damage are more often treated with primary transplant.

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Oncolytic vesicular stomatitis virus synergizes with sunitinib to treat neuroblastoma by modulating immune cell subsets

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Purpose: Survival for high-risk neuroblastoma (NB) remains poor despite pushing the use of conventional therapies to levels that inflict exceptional morbidity on patients, emphasizing the need for innovative treatments. Treatments producing adaptive antitumour immune responses are promising. The oncolytic rhabdovirus, vesicular stomatitis virus delta M51 (VSV\textsubscript{Δ}M51) infects and destroys cancer cells in a way that induces antitumour immunity. Rapid viral clearance and an immunosuppressive tumour microenvironment (TME) are barriers to intratumoural virus spread and anticancer immunity, respectively. The antiangiogenic agent Sunitinib (Su) is also known to improve viral productivity and deplete immunosuppressive cells. We thus hypothesized that Su would modulate the immune response to improve VSV\textsubscript{Δ}M51 productivity in the TME and enhance antitumour immune cells activated by VSV\textsubscript{Δ}M51.

Methods: Immunocompetent A/J mice carrying neuro-2a NB tumours were used to compare treatment responses to VSV, Sunitinib and combination therapy. The effect of each treatment on NB cells alone was determined \textit{in vitro} using cell lines. Cell populations in tumour and TdLN were measured using flow cytometry.

Results: Su/VSV\textsubscript{Δ}M51 therapy elicited tumour regression and cures compared to monotherapy. The productivity of VSV\textsubscript{Δ}M51 in neuro-2a cells grown in culture and in neuro-2a tumours \textit{in vivo} was not altered by Su. Depletion of CD8\textsuperscript{+} T cells abolished the survival advantage elicited by Su/VSV\textsubscript{Δ}M51. The tumour draining lymph node (TdLN) of Su/VSV\textsubscript{Δ}M51 treated mice had fewer myeloid derived suppressor cells and regulatory T cells, and increased CD3+CD8\textsuperscript{+} cells following VSV\textsubscript{Δ}M51 or Su/VSV\textsubscript{Δ}M51 treatment.

Conclusion: Su improves VSV\textsubscript{Δ}M51 therapy for neuro-2A tumours, perhaps via immunosuppressive relief in the TdLN.

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Evaluating quality of life of extracorporeal membrane oxygenation survivors using the pediatric quality of life inventory survey

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Purpose: This study assesses the impact of extracorporeal membrane oxygenation (ECMO) associated morbidities on long-term QOL outcomes.

Methods: After IRB approval (H-39373), we surveyed ECMO survivors (ages 2-18) from 2005-2015 using the 2012 Pediatric Quality of Life Inventory™ (PedsQL™). Cardiac failure ECMO patients were excluded. Demographics, ECMO mode (venovenous [VV] and venoarterial [VA]), clinical outcomes, and QOL scores were compared.

Results: Of 74 patients identified, 64% (35 NICU, 12 PICU) completed the survey at an average 5.5±3 years after ECMO. Twenty-one (60%) NICU patients had congenital diaphragmatic hernia. More NICU patients underwent VA ECMO (66% vs. 17%, p=0.003) compared to PICU patients. VA ECMO had similar ECMO duration (median 9 vs. 7.5 days, p=0.09), but higher overall complication rate (64% vs. 36%, p=0.06), and higher intracranial injury (ischemic or hemorrhagic stroke) rate (48% vs. 5%, p=0.001) compared to VV ECMO. ECMO mode and ICU type did not affect QOL scores [Table1]. Patients with intracranial injury (n=13) had lower overall QOL (59/100±19 vs. 75/100±18, p=0.01), psychosocial functioning (62/100±15 vs. 75/100±16, p=0.01), and physical functioning (56/100±30 vs. 74/100±26, p=0.049) compared to patients without intracranial injury. Cronbach’s alpha correlation was 0.90 for the overall survey.

Conclusion: We conclude that development of intracranial injuries negatively impacts long-term QOL. Although ECMO modes had similar QOL, VV ECMO should be considered as first-line ECMO therapy when clinically feasible due to lower rates of intracranial injuries.
Table. Impact of ECMO mode and intensive care unit type on quality of life

<table>
<thead>
<tr>
<th></th>
<th>NICU (n=35)</th>
<th>PICU (n=12)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at ECMO, Median (IQR)</td>
<td>1 day (0-2 days)</td>
<td>6 years (3-9 years)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Physical Functioning QOL</td>
<td>69/100 ± 29</td>
<td>69/100 ± 27</td>
<td>0.98</td>
</tr>
<tr>
<td>Psychosocial Functioning QOL</td>
<td>71/100 ± 18</td>
<td>75/100 ± 14</td>
<td>0.51</td>
</tr>
<tr>
<td>Overall QOL</td>
<td>70/100 ± 20</td>
<td>73/100 ± 18</td>
<td>0.68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>VA ECMO (n=25)</th>
<th>VV ECMO (n=22)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at ECMO, Median (IQR)</td>
<td>1 day (0-2 days)</td>
<td>3.5 days (1 day-5 years)</td>
<td>0.003</td>
</tr>
<tr>
<td>Physical Functioning QOL</td>
<td>69/100 ± 27</td>
<td>69/100 ± 30</td>
<td>0.99</td>
</tr>
<tr>
<td>Psychosocial Functioning QOL</td>
<td>69/100 ± 16</td>
<td>75/100 ± 17</td>
<td>0.20</td>
</tr>
<tr>
<td>Overall QOL</td>
<td>69/100 ± 18</td>
<td>73/100 ± 20</td>
<td>0.45</td>
</tr>
</tbody>
</table>
Laparoscopic cholecystectomy in Canadian children: what factors impact outcomes?

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Purpose: The incidence of pediatric gallstone disease is increasing with the epidemic of childhood obesity. Since nearly one third of Canadian children are overweight or obese, outcomes after pediatric cholecystectomy are an important public health concern. This study explores the impact of patient and health system factors on morbidity after pediatric laparoscopic cholecystectomy.

Methods: Using administrative databases, children 17 and younger undergoing laparoscopic cholecystectomy in Canada from April 2008 to March 2015 were identified. The primary outcome was all-cause morbidity: any complication that prolonged length of stay by 24 hours or required reoperation. Predictors were modeled using multi-level logistic regression. Low-volume surgeons completed fewer than 50 laparoscopic cholecystectomies over the 7-year period.

Results: Over the study period, 3,519 laparoscopic cholecystectomies were performed in Canadian children, including 2,188 performed by adult general surgeons (median age 16 years, IQR 15-17) and 1,331 by pediatric surgeons (median age 14 years, IQR 12-16). Approximately 98% were for gallstone disease. Overall morbidity was 3.9%. After adjustment, patients with comorbidities were more likely to suffer morbidity (OR = 2.75, 95%CI 1.83 – 3.98, p < 0.001). High-volume general surgeons had a 0.31 decreased odds of morbidity compared to low-volume pediatric surgeons (95%CI 0.12 – 0.68, p = 0.004). Hospital volume had no effect on outcomes (OR 1.45 per 20 case increase, p = 0.34).

Conclusion: High-volume general surgeons have lower morbidity after laparoscopic cholecystectomy compared to low-volume pediatric surgeons. As the rate of gallstone disease increases in Canadian children, surgeon volume should be an important consideration when pursuing operative management.

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The relationship between preoperative nutritional state and adverse outcomes following abdominal and thoracic surgery in children: results from the NSQIP-pediatric database

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Purpose: Childhood malnutrition, defined by anthropometric measurements, is prevalent amongst hospitalized children, yet its role as a predictor of adverse outcome in those undergoing surgery is poorly characterized. Our study aims to: 1) characterize preoperative nutritional status of children undergoing surgery; and 2) describe associations between WHO-defined acute (weight for height) and chronic (height for age) undernutrition (Z-scores < -2) and obesity (BMI Z-scores > +2) with 30-day outcomes.

Methods: The Pediatric NSQIP-P Participant Use File was queried for patients who underwent abdominal or thoracic procedures. Normalized anthropometrics were calculated, including weight-for-height (< 2 years), BMI (≥ 2 years) and height for age. Logistic regression models were developed to assess preoperative nutritional status (Z-scores < -2 or > 2) as an independent predictor of surgical site infection (SSI), deep wound dehiscence, or a composite morbidity outcome.

Results: 23,714 children (88% ≥ 2y) were analyzed. 4,272 (18%) were obese, while 2,640 (11.1%) and 904 (3.8%) were acutely and chronically undernourished, respectively. After controlling for gender, ASA status, procedure, wound classification, preoperative steroid use, and need for preoperative nutritional support, obese children had higher odds of SSIs (OR 1.29, 95% CI 1.1-1.5, p=0.001), while chronically undernourished children were at increased risk of composite morbidity (OR 1.16, 95% CI 1.0-1.3, p=0.036).

Conclusion: Obese children, representing 18% of the cohort, had a 29% higher risk of SSI, while those chronically undernourished had a 16% increased risk of composite adverse outcome. Preoperative nutritional status should be considered a potentially modifiable adverse outcome predictor in children undergoing elective surgery.

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Results after laparoscopic partial splenectomy for children with hereditary spherocytosis: are outcomes influenced by genetic mutation?

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Purpose: Children with hereditary spherocytosis (HS) often require splenectomy. Laparoscopic partial splenectomy (LPS) has the theoretical advantage of maintaining long-term splenic immune function. The aim of this study was to review our results after LPS, and to determine if specific genetic mutations influence outcome.

Methods: After IRB approval, all children with HS undergoing LPS at our institution between 2005 and 2016 were reviewed.

Results: Thirty-one children underwent LPS (16 male) at median age 9 years. All experienced an increase in hemoglobin and decrease in reticulocyte count early after LPS (4-8 weeks) and at last follow-up (median 20 months) (Table). Twenty-two were analyzed for genetic mutations (a-spectrin in 6, b-spectrin in 5, and ANK in 11). Genetic mutation was not correlated with complication rate, perioperative transfusion, length of hospital stay, or median hemoglobin, platelet, or reticulocyte counts early postoperatively or at last follow-up. Three of 31 children required completion splenectomy at 10.9, 6.9 and 3.2 years post-LPS, one with each mutation.

Conclusion: Laparoscopic partial splenectomy is effective in reversing anemia and reducing reticulocytosis. So far less than 10% have required completion splenectomy, and those children did benefit from delaying the risks of asplenia. In this preliminary analysis, genetic mutation did not influence outcome after LPS. A larger multi-centre study is necessary to further investigate potential correlations with specific genetic mutations.

<table>
<thead>
<tr>
<th></th>
<th>Pre-LPS</th>
<th>4-8 wk post LPS</th>
<th>Last visit post-LPS</th>
<th>p value (repeated measures ANOVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Hemoglobin (g/L)</td>
<td>89</td>
<td>123</td>
<td>132</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Median Platelet count (X 10^9/L)</td>
<td>277</td>
<td>542</td>
<td>368</td>
<td>=0.001</td>
</tr>
<tr>
<td>Median Reticulocyte count (%)</td>
<td>16</td>
<td>6</td>
<td>10</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

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Probenecid as a new therapeutic treatment for neuroblastoma?

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Purpose: Despite aggressive surgery and chemotherapy, the survival rate of high-risk neuroblastoma (NB) patients remains below 50%, thus highlighting the urgent need for improved NB treatments. Interestingly, it was recently shown that Pannexin1 (Panx1) channels are expressed in the mouse NB-derived cell line N2a and that the Panx1 channels blocker probenecid reduces N2a cell proliferation. Here our goal is to assess whether inhibition of human PANX1 channels constitute a potential novel NB therapeutic approach.

Methods: PANX1 levels were assessed in NB patient specimens and high-risk NB patient-derived cell lines. PANX1 channel activity was determined using dye uptake assays. Proliferation and apoptosis assays were performed in the presence of probenecid. Statistical significance was analyzed using two-tailed Student’s t-Test (n≥3; *p<0.05). IRB approval attained.

Results: PANX1 is expressed in NB tumours and upregulated in undifferentiated/poorly differentiated specimens. PANX1 channels were also expressed and active in NB cell lines. Importantly, probenecid significantly blocked PANX1 channel activity in these cells, which resulted in slower growth by inhibiting cell proliferation. Furthermore, our preliminary data suggest that in at least some NB cell lines, probenecid treatment triggered concomitant NB cell death through apoptosis.

Conclusion: We found that Pannexin1 channels are expressed in human neuroblastoma and that their inhibition using probenecid reduced neuroblastoma growth in vitro. Together with preclinical experiments in mice, results from this research project will determine whether Pannexin1 is a potential therapeutic target for neuroblastoma. Given that probenecid is already in clinical use to treat gout, translation into clinical trials for neuroblastoma treatment could be expedited.

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Pediatric outcomes associated with delays in access to emergent surgery: a risk stratified analysis

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Purpose: Literature demonstrates that delays to operation for patients with acute surgical emergencies may contribute to potentially avoidable morbidity and mortality. An institutional audit found that delays to the operating room were most likely to occur in Class 1 surgeries (target in room time <=60 minutes). We hypothesized that in high risk patients, delays to surgery would be associated with increased mortality.

Methods: A retrospective review (June 2011-June 2015) of prospectively collected patient and operating room data was undertaken on Class 1 surgeries. Patient charts reviewed, scored using either SNAPII (neonatal) or PRISM (pediatric) and ASA class (>3) based on preoperative parameters. Patients were classified as low or high risk of mortality. Chi-squared analysis and descriptive statistics were used.

Results: There were 394 Class 1 cases for 368 patients: 88 high risk and 280 low risk. Delays to OR (>60 minutes) occurred in 40 high risk patients (45%) and 131 low risk patients (46.8%). In total, there were 31 mortalities; 18/31 (58%) had delays to OR. Twenty one of the 31 patients who died were in the high risk group. Overall for the 368 patients, delay of >60 minutes was associated with increased mortality (10.5% versus 6.6%); in the low risk group, the association between delay and mortality was statistically significant (6.1% versus 1.3%, p=0.032).

Conclusion: The majority of Class 1 emergency surpatients who died experienced a delay to the operating room; the association between mortality and delay was statistically significant in the low risk patient group.

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Pediatric surgeons’ involvement in pediatric palliative care

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Purpose: Pediatric surgeons are often involved in the management of severely or terminally ill patients. However, articles addressing their specific roles in the context of palliative care are almost inexistent. We sought to characterize the involvement of pediatric surgeons caring for children near end of life.

Methods: Chart review of children who had a procedure under general anesthesia within 6 months of their death over five-year period at a tertiary children hospital (excluding traumas and neonatology cases). In addition to demographic and clinical data, we recorded the aim of the procedures performed, the involvement of the palliative care service and presence of DNAR orders.

Results: The analysis included 83 patients with a mean age of 8 years. Forty-four children had more than one procedure (range 2-10). Pediatric palliative care service was involved in 66 cases (80%). A majority of patients had cancer (50%) and the most frequent cause of death was oncologic progression (46%). Ten patients died of a complication following their intervention. The aim of the procedure was palliative in 48 cases (29 for symptoms control and 19 to facilitate care), diagnostic in 16, and curative in 19. Forty-five procedures were performed urgently and 14 despite DNAR orders.

Conclusion: Surgeon’s involvement with children near end of life is not infrequent. The procedures performed are varied and can be categorized according to their aim. Lack of formal palliative care training by surgeons highlights the need for increased collaboration with palliative care services to provide optimal care for children when they need it most.

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The global initiative for children’s surgery: an evidence- and value-based collaboration for improved surgical care of children

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Purpose: Recommendations by the Lancet Commission on Global Surgery regarding the provision of surgical care in low-and-middle-income-countries (LMICs) have largely ignored the unique needs of children. The Global Initiative for Children’s Surgery (GICS) was started in 2016 to “identify solutions to problems in children’s surgery, drawing upon the expertise and experience of practitioners from around the world”. This report details the unique global process and its principles.

Methods: Following provider surveys, two global meetings brought together providers and implementers of surgical services for children with health, advocacy, and policy experts. They reviewed the current situation, developed strategic priorities and processes, and identified necessary resources for implementation. Thematic and specialty working groups were formed under LMIC chairmanship and an Optimal Resources for Children’s Surgery (OReCS) document developed.

Results: The following values undergird GICS:

1. “nothing about us without us” - intentional LMIC provider participation & leadership
2. “children’s surgery”, not just “pediatric surgery” - including all professionals and specialties involved in the surgical care of children
3. focus on holistic capacity-building - multi-sector approach including infrastructure, material/human resources, training, research and advocacy
4. intensely collaborative ethos among providers from differently-resourced environments;
5. grassroots – informed and led by active clinical providers
6. trainee involvement – at all levels, integral to the mission; function rather than form – an informal, flexible volunteer organization

Conclusion: The unique GICS processes and values are conducive to its vision: “Every child in the world who has a surgical need will have access to resources that will optimize his or her individual care.”

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Optimal resources for children's surgery - birth, development, and maturation of a comprehensive guideline document for global children's surgery

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² Department of General Surgery, McGill University Health Centre, Montreal, Québec, Canada
³ Département de chirurgie générale, Université de Montréal, Montreal, Québec, Canada

Purpose: The Global Initiative for Children’s Surgery (GICS) endeavours to “identify solutions to problems in children’s surgery, drawing upon the expertise and experience of practitioners from around the world.” Central to this mission is the Optimal Resources for Children’s Surgery (OReCS) document, highlighted in this presentation.

Methods: Following needs surveys completed by low- and middle-income countries (LMIC) providers, multiple thematic and specialty working groups convened under LMIC leadership. They reached consensus on marker children’s surgical conditions and on the infrastructure, material and human resources, training and research required for the optimal surgical care of children.

Results: Input in OReCS was received from thematic (infrastructure/standards, human resources/training, research/quality improvement, funding/policy/advocacy, anesthesia/critical-care) and specialty groups (cardiac surgery, neurosurgery, oral surgery, trauma, orthopedic surgery, plastic surgery, urology, general surgery, otorhinolaryngology, ophthalmology). Resources for all specialties were integrated and classified as “essential” or “desirable” at each WHO level of care (community, first-level, second-level, third-level, and national hospital), see table 1.

Conclusion: GICS’ OReCS is an encompassing document created through wide integration of stakeholders’ input and unprecedented collaboration across surgical disciplines. The document sets a new benchmark for the surgical care of children around the globe. Following planned endorsement by the WHO, it is expected that OReCS will assist in formulating national children’s surgical plans.
### Table 1. Outline table for desirable resources at each WHO level of care

<table>
<thead>
<tr>
<th>Type of facility (based on DCP3 classification)</th>
<th>Community facility and primary health center</th>
<th>First-level hospital</th>
<th>Second/Third-level hospital</th>
<th>National children’s hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Care</strong></td>
<td>I</td>
<td>I, II</td>
<td>I, II, III</td>
<td>I, II, III</td>
</tr>
<tr>
<td><strong>Responsibilities</strong></td>
<td>Screening for surgical disease</td>
<td>Resuscitation, Referral to higher levels of care, Emergency surgical care</td>
<td>Diagnosis and treatment of common surgical diseases</td>
<td>24/7 Emergency Surgical Care, Comprehensive surgical care for children&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Age Treated</strong></td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td><strong>General Anesthesia</strong></td>
<td>No</td>
<td>Yes, not including complex cases and minimal comorbidity (Limit of ASA I or II)</td>
<td>Yes, including some complex cases and comorbidities (Limit of ASA III)</td>
<td>Yes, including complex cases and comorbidities (All ASA)</td>
</tr>
<tr>
<td><strong>Human resources</strong></td>
<td>Existing personnel Community Health Workers</td>
<td>Existing personnel Anesthesia provider</td>
<td>Specialists in some areas of children’s surgical care provided (level II)</td>
<td>Specialists in all areas of children’s surgical care provided (level III)</td>
</tr>
<tr>
<td><strong>Required skills</strong></td>
<td>Basic assessment and treatment skills</td>
<td>Skills to treat emergency and essential childhood surgical conditions</td>
<td>Advanced surgical and anesthesia skills in all majority of children’s surgical care</td>
<td>Advanced surgical and anesthesia skills in all areas of children’s surgical care</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>Existing infrastructure</td>
<td>Children’s ward Functional operating room</td>
<td>Children’s wards, clinics, operating rooms, NICU, PICU Burn unit (level III)</td>
<td>Wards, clinics, operating rooms, NICU, PICU, burn unit</td>
</tr>
<tr>
<td><strong>Equipment &amp; supplies</strong></td>
<td>Wound care supplies</td>
<td>Emergency and essential surgical equipment &amp; supplies for children</td>
<td>Equipment and supplies to fully support services provided</td>
<td>Equipment and supplies to fully support services provided</td>
</tr>
<tr>
<td><strong>Quality and safety</strong></td>
<td>CME/CPD Periodic supervision and mentoring</td>
<td>CME/CPD Periodic supervision and mentoring M&amp;M review</td>
<td>CME/CPD Periodic supervision and mentoring M&amp;M review Trauma conference Tumor Board</td>
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CAPS Annual Meeting CME

15.33 Section 1 credits and 4 Section 3 credits
15.33 crédits de la section 1 et 4 crédits de la section 3

Link contained in the QRS code for Section One Credits only is https://www.surveymonkey.com/r/CAPS-CME2017