



Do all-cause revisit rates reflect the quality of pediatric surgical care provided during index encounters?★



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ABSTRACT

Purpose: The purpose of this study was to compare the relatedness of revisits to the index surgical encounter across different pediatric surgical procedures and to explore whether all-cause revisit rates are an accurate surrogate measure for related revisits in this cohort of children.

Methods: We reviewed all-cause revisits occurring within ninety days of the thirty most commonly performed pediatric surgical procedures at 44 children's hospitals between 1/1/2012 and 3/31/2015. For each condition, a team of four surgeons reviewed revisit diagnoses and reached consensus around relatedness to the index surgical encounter. Chi-squared tests were used to test for variation in all-cause and related revisits among procedures. Spearman's correlation coefficient was used to measure the association between rankings of procedures by their all-cause and related revisit rates.

Results: 144,535 index encounters were analyzed with an overall revisit rate of 15.0% (21,732). Significant variation was found in both the rates of all-cause revisits among procedures (ranges: 7.6–68.4%, $p < 0.0001$), and in the relative proportions of revisits related to the index surgical encounter (range: 0% to 77%, $p < 0.0001$). Poor correlation was found between procedure rankings based on all-cause revisit rates and revisit rates related to the index admission ($r = 0.33$, $p = 0.07$).

Conclusions: The relative proportion of revisits related to the index encounter varies significantly across pediatric surgical conditions, and poor correlation exists at the procedure-level between all-cause and related revisit rates.

Level of evidence: IV.

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Hospital readmission poses a significant financial burden for hospital systems, patients, and payors alike [1–3]. Reduction of inpatient and emergency department (ED) revisits has therefore become a high-priority focus of many hospital-wide quality improvement (QI) initiatives. While all-cause revisit rates may reflect the quality of broader systems of care within hospitals, they may not accurately reflect the quality of care provided by the surgical team during and following the index surgical admission [4–6]. In this regard, there are many reasons that a child might return to the system following discharge. These include complications of the surgical procedure, complications or scheduled revisits associated with an underlying chronic medical condition (e.g. oncologic diagnoses), or reasons entirely

unrelated to the index surgical procedure or underlying chronic condition. The relative distribution of these revisit diagnoses is likely to be quite different across the spectrum of pediatric surgical procedures, bringing into question the validity of using all-cause revisit rates as a surrogate for revisits truly related to the index surgical encounter.

With the considerations above, the purpose of the present study was two-fold. First, we sought to characterize the relatedness of revisit encounters to the index admission for commonly performed general pediatric surgical procedures. Second, we aimed to explore whether all-cause revisit rates are an accurate surrogate for revisits considered related to the index surgical encounter. We hypothesized that great variation in the rates of related revisits would be found across different pediatric surgical procedures, and furthermore, that correlation between rates of all-cause and related revisits would be relatively poor. The practical implications of this analysis were to identify procedures where the greatest relative opportunities for revisit prevention by the pediatric surgical team might exist in perioperative and post-discharge care. Furthermore, the results of this study could be used to provide a framework for meaningful comparative performance among

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pediatric surgery departments on the basis of revisits relating to surgical care.

1. Methods

1.1. Study design and data source

This study was a retrospective cohort analysis using the Pediatric Health Information System (PHIS) database, which contains detailed administrative and billing data from 44 freestanding children's hospitals affiliated with the Children's Hospital Association (Overland Park, KS). Patient-level data available in PHIS includes demographic and payer information, primary and secondary *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnostic and procedural codes, and date-stamped billing data for a wide range of clinical services including diagnostic tests and therapeutic procedures. All patients in PHIS are assigned a unique identifier that can be used to track patients through subsequent readmission and revisit encounters. Data quality is facilitated by systematic monitoring including consistency reviews, coding consensus meetings, and quarterly data reports.

1.2. Study cohort

We identified all patients undergoing surgery for one of the 30 most commonly performed general pediatric procedures from 1/1/2012 to 3/31/2015. We chose to focus on the top 30 procedures because of a preliminary analysis that demonstrated that this cohort accounted for greater than 80% of case volume in general pediatric surgery during the study period. The data query was restricted to index encounters with a preoperative length of stay of 2 days or less in order to exclude patients where the indication for hospitalization may have been related to reasons other than those associated with the operative procedure. All patients meeting inclusion criteria were assessed for a revisit to the emergency department or readmission to the inpatient setting within 90 days of discharge from the index encounter.

1.3. Diagnosis-procedure pairs as the unit basis for readmission analysis

Prior to analyzing revisit rates, we first reviewed all ICD-9 procedure and diagnosis codes associated with index encounters to create clinically relevant diagnosis-procedural pairings for each condition. This was necessary to distinguish different disease processes requiring the same procedure that may have different implications for readmission risk (e.g. colectomy for Hirschsprung's disease versus colectomy for ulcerative colitis). Encounters where more than one of the 30 targeted procedures was performed at the same time were excluded in order to provide a more accurate assessment of revisit risk attributable to specific procedures. The single exception to this exclusion was an encounter when a gastrostomy was combined with a fundoplication. We included these cases as a unique cohort as we felt that the risk of revisits was particularly high owing to the procedures and unique cohort of children undergoing these procedures.

1.4. Defining relatedness to index surgical encounter

For each condition, a team of four surgeons reviewed principal ICD-9 diagnosis codes that were associated with at least 1% of all revisit encounters for that condition, and then established consensus on the degree of relatedness to the index surgical encounter. The surgical team met on a weekly basis to collectively review revisit diagnoses and assign one of three possible categories of relatedness: very likely, possibly, or very unlikely related. A revisit diagnosis was considered very likely related if it could not have occurred without the index surgical procedure (e.g. wound infection following appendectomy) and possibly related if the diagnosis could be attributed to either a post-operative complication or unrelated condition (e.g. fever following

appendectomy). A revisit diagnosis was considered very unlikely to be related to index surgical care if the surgical procedure would likely not have contributed to the diagnosis (e.g. otitis media following appendectomy).

1.5. Analysis of all-cause revisit rates and the relative proportion of related revisits

All-cause revisit rates for each procedure were calculated by dividing the number of patients that had at least one revisit (ED or inpatient) within ninety days of discharge from the index admission by the total number of patients undergoing the procedure. Only the first revisit occurring within the 90-day follow-up period was included in the analysis. We then calculated the proportion of related revisits for each condition based on revisit encounters that were categorized as very likely related. Chi-Squared tests were used to test for variation in the proportion of related revisits across procedures. Spearman's correlation coefficient was used to measure the association between rankings of procedures by their all-cause and related revisit rates. In order to provide a more conservative assessment as to whether all-cause revisit rates were an accurate surrogate for related revisit rates, we repeated the analysis after redefining relatedness to include revisit encounters that were categorized as possibly related as well as very likely related.

All statistical analysis was performed using SAS v. 9.4 (SAS Institute; Cary, NC). The Institutional Review Board of Boston Children's Hospital deemed this study exempt from review under 45 CFR 46.102(f).

2. Results

We analyzed 144,535 index surgical encounters meeting inclusion criteria, of which 15.0% (21,732) had at least one revisit within 90 days of discharge. Of these, 13,860 encounters were associated with a revisit diagnosis that contributed more than 1% of all revisit encounters for a specific procedure. (Fig. 1).

2.1. All-cause revisit rates and the relative proportion of related revisits

All-cause revisit rates ranged from 7.6% to 68.4% across procedures, with the highest rates associated with ulcerative colitis (68.4%), hepatoblastoma (65.3%), fundoplication combined with gastrostomy (63.6%), neuroblastoma (61.4%), and Wilms tumors (54.6%). Conditions with the lowest all-cause revisit rates included undescended testes (7.6%), umbilical hernia (7.9%), inguinal hernia (8.9%), pectus excavatum (10.3%), and ovarian torsion (10.6%).

Of the 13,860 revisit encounters reviewed, 37.8% (5236) were categorized as very likely related, 43.0% (5967) possibly related, and 19.2% (2657) very unlikely related. The proportion of revisits likely related to the index hospitalization was significantly different across procedures (range: 0% to 77%, $p < 0.0001$), with the highest proportions associated with complicated appendicitis (77%), imperforate anus (66%), and uncomplicated appendicitis (61%) (Fig. 2). When using the more conservative definition of relatedness that included revisit diagnoses that were categorized as possibly related as well as very likely related, the proportion of related revisits remained significantly different across procedures (range: 28% to 100%, $p < 0.0001$). All revisits following management of complicated appendicitis, pectus excavatum, and pilonidal disease were considered related using this definition, and very high rates of related revisit rates were also found with Hirschsprung's disease (97.8%), ovarian cyst (97.4%), imperforate anus (96.1%), and uncomplicated appendicitis (93.1%).

2.2. Correlation between all-cause revisit rates and related revisits

Revisit rates very likely related to the index surgical admission were on average 83% lower than all-cause revisit rates (range of decrease by procedure: 39–100%), and relatively poor correlation was found

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