# Readmission after Gastrointestinal Bleeding in Children: A Retrospective Cohort Study

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**Introduction** To compare the demographic, clinical, and therapeutic characteristics in a cohort of patients discharged following acute gastrointestinal bleeding, representing to the emergency department (ED) and readmitted within 30 days of discharge with the characteristics of non-readmitted patients.

**Study design** Hospitalization data was obtained from the Pediatric Hospital Information System including 49 tertiary children's hospitals in the US. Children 1-21 years of age diagnosed with acute gastrointestinal bleeding, admitted between January 2007 and September 2015 were included. The primary outcomes in this study were 30-day inpatient readmission through the ED and 30-day return to the ED only. Unadjusted, univariate followed by multivariable analysis of the associations between patient characteristics and treatment course at the index encounter using the R statistical package, v. 3.2.3.

**Results** During the study period, 9902 patients were admitted with acute gastrointestinal bleeding; in the following month, 1460 (16.1%) represented to the ED and 932 (9%) were readmitted; 68.7% within 14 days from discharge. Readmission was most frequently associated with portal hypertension or esophageal variceal hemorrhage. There was a decreased likelihood of readmission with endoscopy (OR 0.77, 95% CI, 0.661, 0.906) and with Meckel scan (OR 0.513, 95% CI 0.362, 0.727) during the initial admission. Multiple comorbidities, longer initial stay and the early proton pump inhibitor therapy were associated with higher likelihood of readmission.

**Discussion** Readmission following acute gastrointestinal bleeding is common and is more likely following variceal hemorrhage, long initial admission, and chronic comorbidities. *(J Pediatr 2017;184:106-13).*

Acute gastrointestinal bleeding in children is a challenging clinical presentation that may warrant inpatient care and emergent medical management including therapeutic endoscopy.[1,2] The appropriate triage and subsequent management of acute gastrointestinal bleeding in children presents several challenges, and the pediatric literature significantly lags behind the published studies in adults that include several predictive pre-endoscopic (clinical Rockall score, Glasgow-Blatchford score)[3,4] and combined clinical and endoscopic based scoring systems (Rockall, Baylor Bleeding Score, Cedars-Sinai Medical Centre predictive index).[5-7] These serve to predict the need for therapeutic endoscopy and the likelihood of adverse outcomes including length of stay, mortality, rebleeding, and readmission.[8] Given the prevalence of age and age-related comorbidities in these scoring methods, they cannot be generalized to pediatric practice.

In children, the Sheffield Scoring System[9] identified clinical factors identifiable at the time of presentation that predict the need for therapeutic endoscopy during the encounter. These include the presence of pre-existing disease including liver disease, need for intravenous volume support, blood transfusion, increase in heart rate (>20 bpm above age adjusted mean), delay in capillary refill, large hematemesis, melena, and drop in hemoglobin >20 g/L. Although useful in initial management, this scoring method has clear limitations in determining length of stay (LOS) and likelihood of rebleeding.

Rebleeding in adult patients can best be anticipated by the endoscopic characteristics of the bleeding source if identified (Forrest score).[10] Intuitively, given similar pathophysiologic processes resulting in bleeding in both adult and pediatric populations we can, to some extent, classify our patients' likelihood to rebleed through their endoscopic findings. Although generalizing pediatric outcomes from adult patient-based research may be a reasonable assumption, there is still a considerable subgroup of children admitted with acute gastrointestinal bleeding and not endoscoped but in whom we do not have any measure to predict rebleeding including after discharge.

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| ED | Emergency department |
| ED-IP | 30-day inpatient readmission through the ED |
| GIB | Gastrointestinal bleed |
| H2RA | Histamine H2 receptor antagonist |
| ICD-9 | *International Classification of Diseases, Ninth Revision* |
| LOS | Length of stay |
| PHIS | Pediatric Hospital Information System |
| PPI | Proton pump inhibitor |
| PRBCs | Packed red blood cells |

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This study compared the clinical, demographic, and prior therapeutic approaches that may predict those children more at risk of rebleeding and readmission in comparison with those that did not manifest this.

## Methods

We conducted a retrospective cohort study using data obtained from the Pediatric Hospital Information System (PHIS), an administrative database that contains inpatient, emergency department (ED), and observation encounter-level data from 49 not-for-profit, tertiary care pediatric hospitals in the US. These hospitals are affiliated with the Children's Hospital Association (Overland Park, Kansas). Data quality and reliability are assured through a joint effort between the Children's Hospital Association and participating hospitals. Portions of the data submission and data quality processes for the PHIS database are managed by Truven Health Analytics (Ann Arbor, Michigan). For the purposes of external benchmarking, participating hospitals provide discharge/encounter data including demographics, diagnoses, and procedures. Nearly all of these hospitals also submit resource utilization data (eg, pharmaceuticals, imaging, and laboratory) into PHIS. Data are deidentified at the time of data submission, and data are subjected to a number of reliability and validity checks before being included in the database. The PHIS hospitals are 49 of the largest and most advanced children's hospitals in America, and constitute the most demanding standards of pediatric service in North America. Hospitals are adopted into the PHIS database on a rolling basis, and for the study period queried in this paper data from 46 hospitals was available. This study was approved by the Institutional Review Board (16050358).

Children between the ages of 1 and 21 years at the time of admission were eligible for inclusion if they were diagnosed with an upper gastrointestinal bleed (GIB) or a bleed of indeterminate location and admitted as an inpatient or under observation with ED charges between January 1, 2007 and September 30, 2015. Study participants with upper or indeterminate bleeding were identified through *International Classification of Diseases, Ninth Revision* (ICD-9) discharge diagnosis codes (**Table I**; available at www.jpeds.com). We then looked at patients readmitted to the ED only, excluding those admitted directly to inpatient or outpatient as they were more likely scheduled visits. Patients readmitted to the ED within 30 days of discharge were categorized as those who were seen in the ED only (ED), and those who were readmitted in the ED and subsequently admitted as inpatients or under observation within 30 days of discharge [30-day inpatient readmission through the ED (ED-IP)]. If a patient had multiple readmissions (1 to the ED and 1 as ED-IP, but as separate encounters), the patient was coded as requiring inpatient readmission rather than ED only.

Demographic characteristics included age in years at time of admission, sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Asian, other, unknown), and rural vs urban zip code of residence. Complex chronic conditions were defined using a previously described ICD-9 coding scheme for 9 types of complex chronic conditions (neuromuscular, cardiovascular, respiratory, renal, gastrointestinal, hematologic/immunologic, metabolic, congenital or genetic, and malignancy), as well as organ transplant patients and technology dependent patients.[1,2] A given patient could have could have more than 1 complex chronic condition, and the total number of complex chronic conditions for each patient was calculated. Chronic liver disease was also identified by ICD-9 diagnosis codes, and coded as a dichotomous variable. The need for packed red blood cell transfusions was used to control for severity of bleeding (0 = no transfusion, 1 = transfusion(s) received), and the need for platelet transfusion were coded dichotomously (0 = no transfusion, 1 = transfusion(s) received). LOS was log-transformed.

Procedures were identified through ICD-9-CM codes, and pharmaceuticals and imaging procedures were identified through Clinical Transaction Classification system for revenue codes.

The primary outcomes of interest in this study were 30-day readmission (ED-IP and ED only).

### Statistical Analyses

Unadjusted, univariate analyses of the associations between patient characteristics and treatment course at the index encounter were carried out. Continuous variables were summarized using the median and IQR and compared using the Wilcoxon rank-sum test. Categorical variables were summarized using counts and frequency as a percentage, and compared using the $\chi^2$ test of association or Fisher exact test, where appropriate. Complex chronic conditions were treated categorically as the number of complex chronic conditions present in a single patient. The levels of the category were defined as 0 complex chronic conditions, 1 or 2 complex chronic conditions, and 3 or more complex chronic conditions. These levels were chosen after assessing the median and IQR of the distribution of number of complex chronic conditions. Receipt of pharmaceuticals on the first or second day of admission was coded as a dichotomous variable, as was the receipt of packed red blood cell transfusions and platelet transfusions. Diagnostic imaging on the first, second, or third day of admission was coded as 0 (imaging not obtained) and 1 (imaging obtained). All procedures were coded as 0 (procedure not billed) or 1 (procedure billed). Unadjusted *P* values were reported for the univariate analysis.

Adjusted analysis of the association between patient characteristics and treatment course during the index encounter with readmission were examined using multivariable generalized linear mixed models to assess the odds of exposure to treatment among readmission cases (binomial family, logit link). A quasi-likelihood method was used to estimate effects (Laplace approximation). All candidate models were adjusted for potential confounding by age in years at admission, race/ethnicity, and sex. Chronic liver disease, comorbid complex chronic conditions, and rural vs urban zip code of residence at time of admission were tested as covariates. Other covariates included perforation type injury, administration of proton pump inhibitor (PPI), histamine H2 receptor antagonist (H2RA),