Predictors of Clinically Significant Upper Gastrointestinal Hemorrhage Among Children With Hematemesis

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ABSTRACT

Objectives: The aim of the study was to determine the proportion of children with hematemesis who experience a clinically significant upper gastrointestinal hemorrhage (UGIH) and to identify variables predicting their occurrence.

Methods: A retrospective cohort study was conducted. All of the emergency department visits by children ages 0 to 18 years who presented with hematemesis between 2000 and 2007 were reviewed. The primary aim of the study was to determine the proportion of children who developed a clinically significant UGIH; the secondary aim was to identify risk factors predictive of a clinically significant UGIH. A significant UGIH was defined by any of the following: hemoglobin drop >20 g/L, blood transfusion, or emergent endoscopy or surgical procedure.

Results: Twenty-seven of 613 eligible children (4%; 95% confidence interval 3%–6%) had a clinically significant UGIH. Clinically significant hemorrhages were associated with older age (9.7 vs 2.9 years; $P < 0.001$), vomiting moderate to large amounts of fresh blood (58% vs 20%; $P < 0.001$), melena (37% vs 5%; $P < 0.001$), significant medical history (63% vs 24%; $P < 0.001$), unwell appearance (44% vs 6%; $P < 0.001$), and tachycardia (41% vs 10%; $P < 0.001$). The frequency of laboratory investigations increased with age ($P < 0.001$). The hemoglobin level was the only laboratory investigation whose results differed between those with and without significant bleeds. The presence of any one of the following characteristics identified all of the children with a clinically significant hemorrhage: melena, hematochezia, unwell appearance, or a moderate to large volume of fresh blood in the vomitus, sensitivity 100% (95% confidence interval 85%–100%).

Conclusions: The occurrence of a clinically significant UGIH was uncommon among children with hematemesis, especially in well-appearing children without melena, hematochezia, or who had not vomited a moderate to large amount of fresh blood.

Key Words: emergencies, gastrointestinal hemorrhage, hematemesis

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Hematemesis, the vomiting of blood, is an uncommon but potentially serious event that may require aggressive emergency department (ED) treatment. The presenting appearance can be that of bright red blood or a dark-colored liquid (ie, ''coffee grounds'') (1). Regardless of the underlying cause, hematemesis frequently results in medical interventions and significant parental anxiety. Laboratory testing is rarely helpful in identifying the cause of the bleeding, and although nasogastric tube insertion with diagnostic saline lavage is often recommended (1), its usefulness remains debatable (2,3).

Data to support an evidence-based treatment approach to children presenting with hematemesis is limited (4) to case reports, case series, and small cohort studies (5–8). There is an absence of a large, ED-based cohort study that describes outcomes in children who present with hematemesis. Consequently, the recommended diagnostic and therapeutic approaches are similar to those used in adults (9). Hence, there is a need for a study that better describes which children are at risk for a clinically significant gastrointestinal bleed and require the performance of investigations and interventions.

We conducted a review of the clinical features, test results, and diagnoses in a consecutive series of children who presented to the ED with hematemesis. Our objectives were to determine, among children with hematemesis, the proportion who experience a clinically significant gastrointestinal hemorrhage, and to identify risk factors that predict the occurrence of a clinically significant gastrointestinal hemorrhage.

METHODS

Study Design and Setting

This retrospective report includes data from a consecutive series of children up to 18 years of age who presented to the ED between May 1, 2000 and April 30, 2007 with a chief complaint or diagnosis consistent with hematemesis. This single-center study was conducted at The Hospital for Sick Children, a tertiary care referral hospital in downtown Toronto.

Population

Children were identified by searching the ED's electronic database using a chief complaint family word root search for ''hem,'' ''blood,'' ''bld,'' and ''coff'' and the ED's discharge database using *International Classification of Diseases (ICD)-10* codes (Table 1). Children were excluded if the diagnosis meeting our search criteria was assigned during hospitalization (ie, patients who were admitted for other reasons and developed hematemesis while in the hospital); the searches identified duplicate cases; and evidence of hematemesis could not be identified during the chart review.

Data from potentially eligible patient visits was abstracted from our electronic patient chart system using a standardized data collection instrument. All of the hospitalizations subsequent to the index visit were reviewed to determine whether an alternative diagnosis was identified and clinically significant bleeding events

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TABLE 1. *International Classification of Diseases-10* search terms

I85.5 (esophageal varices)
K20 (esophagitis)
K21.1 (gastroesophageal reflux disease with esophagitis)
K22.1 (esophageal ulcer)
K25 (gastric ulcer)
K26 (duodenal ulcer)
K27 (peptic ulcer)
K29 (hemorrhagic gastritis)
K55.8 (vascular malformation of stomach)
P54 (neonatal hemorrhage)
Q39.8 (duplication cyst)
Q40.2 (malformation of stomach)

occurred. The study was approved by the hospital's research ethics board; written informed consent was not required.

Study Protocol

The analysis considered historical variables (eg, duration and frequency of vomiting, presence of diarrhea, presence of fresh blood or coffee grounds, volume and duration of hematemesis), medical history, physical examination (eg, vital signs, general description, pertinent findings), stool and vomit testing to confirm presence of blood, laboratory blood tests, and diagnostic imaging. Normal values for heart rate and blood pressure were based on accepted standards (10). Also recorded were all ED interventions, consultations, the performance of a therapeutic endoscopy, location and duration of hospitalization, and subsequent ED visits possibly related to the index visit. All of the primary data abstractors (C.S., M.R.) were trained, in person, by the study's principal investigator (S.F.), and they were blinded to the study's hypothesis. For data abstraction, a coding manual was provided that contained a clear set of protocols and guidelines to instruct the reviewers on the abstraction of data from the health record (11). The manual listed each variable, explained how the variable was to be captured in the data abstraction instrument, described where the variables are located in the health record, and provide the required protocols to extract the data. An explicit protocol was designed to increase the interrater reliability of data abstraction (12).

Unavailable data were coded as missing except for particular presenting symptoms (eg, diarrhea, hematochezia, melena, abdominal pain), relevant medical histories, the presence of hypotension, and the performance of diagnostic testing, for which the absence of a specific description in the chart was interpreted as "not present" or "not done." A second reviewer (J.T.F.), unblinded to the study's hypothesis, examined all of the positive clinical outcomes to confirm a relation with the bleeding event. When multiple sources of documentation were present, that of the most senior individual was used (ie, ED staff physician then fellow then resident). If physician documentation was unavailable, then nursing documentation was reviewed. To evaluate interobserver reliability, 10% of charts identified at random, using a random number generator (Microsoft Office Excel 2007, Redmond, WA), were reviewed in a blinded fashion by independent reviewers with data recorded on separate data collection forms.

A significant medical history was defined by a history of any of the following: diseases of the gastrointestinal tract (congenital malformations [eg, malrotation, Hirschsprung disease, vascular, tracheoesophageal fistula], esophagitis, gastric or duodenal ulcer, esophageal varices, *Helicobacter pylori* infection, inflammatory bowel disease, earlier upper gastrointestinal bleed), diseases that predispose to bleeding (eg, end-stage liver disease, coagulopathy), recurrent vomiting syndromes (eg, bulimia nervosa, cyclic vomiting syndrome, gastroesophageal reflux disease), indwelling devices that may result in erosion of the gastrointestinal mucosa (eg, surgically repaired complex congenital heart disease, feeding tubes), and systemic diseases that place children at significant risk (eg, malignancy, organ transplant, significant development delay). All of the historical variables were documented before reviewing the outcome, treatment, investigations, and laboratory results.

General appearance was classified as well ("well-appearing," "no apparent distress," "alert," "normal mental status," "interactive," "smiling") or unwell ("sick," "toxic," "shocky," "decreased mental status," "lethargic," "unresponsive," "irritable," "fussy," "inconsolable," "not looking well," "poor or decreased perfusion," "decreased pulses"); (13) volume of hematemesis was classified as small ("coin," "drop," "fleck," "little," "slight," "small," "some," "speck," "spit," "spot," "streak," "teaspoon," "tinge," "trace"), moderate ("chunks," "clot," "handful," "moderate," "mouthful,"), or large ("covered in blood," "cup," "impressive," "large," "lots," "significant"). When volumes were reported, they were classified as small (0–15 mL), moderate (15–250 mL), and large (>250 mL). Descriptors that did not meet the above definitions were labeled as "unclear."

Study Aims

The primary aim of the present study was to determine the proportion of children who had a clinically significant upper gastrointestinal hemorrhage (UGIH). The secondary aims were to identify risk factors available upon ED presentation that predict the occurrence of a clinically significant UGIH and to determine the diagnostic test characteristics of a rule derived using identified risk factors.

A significant UGIH was defined by the presence of any one of the following:

1. A drop in hemoglobin >20 g/L within 48 hours of the initial hemoglobin (14)
2. The administration of a blood transfusion within 48 hours of presentation (14)
3. The performance of endoscopy or surgical procedure to stop ongoing bleeding or performed emergently (within 4 hours of ED presentation)

Data Analysis

The required sample size was calculated to yield a stable estimate (±2%) of the primary outcome measure. Based on a survey of experienced pediatric emergency medicine physicians, we estimated that 5% of our sample would have a clinically significant UGIH. Thus, a minimum sample of 429 subjects would be required. Sample size calculations were conducted with the use of PASS 2008 (NCSS, Kaysville, UT).

Frequency counts and percentages are given for discrete variables; means, medians, SDs, and interquartile ranges are provided for continuous variables. The χ^2 test was used for discrete variables. Between-group differences in continuous variables were analyzed using the 2-sample *t* test and Mann-Whitney *U* test for normally and non-normally (ie, age) distributed data, respectively. When the number of observations in any given cell of the contingency table was <10, the Fisher exact test was used.

Because of the small number of children with clinically significant gastrointestinal hemorrhage, logistic regression analysis could not be performed (15). Volume of fresh blood vomited was dichotomized to facilitate the clinical applicability of our findings into none/small and moderate/large.

Oxygen saturation and blood pressure were removed from the dataset because <90% of the cohort had these variables documented (16,17). Interobserver agreement among the data abstractors was evaluated with the Cohen kappa (κ) statistic. Agreement was considered fair to good if κ values were between 0.40 and 0.75 and high if values were >0.75. All of the statistical tests were conducted with the use of SPSS 16.0 (SPSS Inc, Chicago, IL). Because multiple comparisons increase the probability of having a statistically significant finding through chance alone, a Bonferroni correction was applied to the analyses presented in each table (18). The Bonferroni correction divides the type I error (0.05) by the number of comparisons to yield a more conservative *P* value that is then used to assign statistical significance. For example, in Table 2, a *P* value that is <0.05 divided by 22 (22 comparisons) or 0.002 is considered statistically significant. No specific funding was provided for the conduct of the present study.

RESULTS

A total of 316,020 ED visits occurred during the study period. The root word search identified 3531 potentially eligible subjects:

1. ''blood'' = 2406
2. ''bld'' = 886
3. ''hem'' = 217
4. ''coff'' = 22

The discharge database *ICD-10* search identified 662 cases. A total of 613 children met the inclusion criteria, 116 were duplicates, and 3464 were excluded because chart review did not identify the presence of hematemesis (ie, bleeding was from an alternate site—most commonly rectal; Fig. 1). Hematemesis accounted for 0.2% of all ED visits. Eligible patient charts were reviewed a median of 6.1 years following the index visit (interquartile range 4.3–7.8 years). The first year of life was the most common presenting age, representing 34% (206/613) of our total cohort, with a gradual decline, eventually reaching a steady level by approximately 5 years of age (67% or 410/613, younger than 5 years).

Main Results

Four percent (27/613; 95% confidence interval [CI] 3%–6%) of our cohort met our definition of clinically significant gastrointestinal hemorrhage (Table 2). The most commonly identified cause was varices (Table 3). The outcome criteria that were met (not mutually exclusive) were drop in hemoglobin >20 g/L (9), blood transfusion (15), and therapeutic surgical or endoscopic intervention (14). The most common discharge diagnosis among children who did not have a clinically significant hemorrhage was ''hematemesis'' (*ICD-10* code K92.0). Nearly all of the diagnoses in this group were based on history and physical examination without endoscopic supportive evidence.

TABLE 2. Comparison of historical and clinical features between children who did and did not have a significant gastrointestinal hemorrhage

	Missing N (%)	Clinically significant gastrointestinal hemorrhage, N = 27	Clinically insignificant gastrointestinal hemorrhage, N = 586	$P^{\dagger}$
Age, y, median (25–75 IQR)	0	9.7 (3.8–13.8)	2.9 (0.4–6.7)	<0.001
Sex, male (%)	0	12 (44)	294 (50)	0.56
No. days vomiting, mean ± SD	0	1.1 ± 0.3	1.8 ± 4.2	0.40
Frequency of vomiting past 24 h, mean ± SD	0	3.0 ± 3.1	3.1 ± 3.8	0.87
Coffee grounds present, N (%)	0	9 (33)	150 (26)	0.37
Coffee grounds, moderate-to-large amount, N (%)	37 (6)	6 (23)	47 (9)	0.03
Fresh blood present, N (%)	2 (0.3)	23 (85)	487 (83)	0.81
Fresh blood, moderate or large amount, N (%)	75 (12)	14 (58)	101 (20)	<0.001
Diarrhea, N (%)	3 (1)	3 (11)	76 (13)	1.0
Hematochezia, N (%)	0	4 (15)	16 (3)	0.009
Melena, N (%)	0	10 (37)	28 (5)	<0.001
Stool occult blood tested in ED, N (%)	0	0	23 (4)	0.62
Abdominal pain, N (%)	0	10 (37)	125 (21)	0.05
Significant medical history, N (%)	0	17 (63)	141 (24)	<0.001
Significant family history, N (%)	0	0 (0)	10 (2)	1.0
Recent medication (NSAID, steroid) use, N (%)	0	4 (15)	36 (6)	0.09
Unwell appearance, N (%)	0	12 (44)	53 (9)	<0.001
Heart rate, bpm, mean ± SD	0	127 ± 27	120 ± 25	0.16
Heart rate outside range of normal, (10) N (%)	0	11 (41)	60 (10)	<0.001
Respiratory rate, breaths/min, mean ± SD	17 (3)	29 ± 14	24 ± 12	0.09
Hypotension, N (%) (10)*	0	2 (7)	10 (2)	0.09
Capillary refill time >2 s, N (%)	45 (7)	2 (7)	10 (2)	0.09

ED = emergency department; IQR = interquartile range; NSAID = nonsteroidal anti-inflammatory drug; SD = standard deviation.
* Denominator includes all of the patients and assumes that patients who did not have blood pressure documented were normotensive.
† *P* value of significance for this table is set at 0.002.

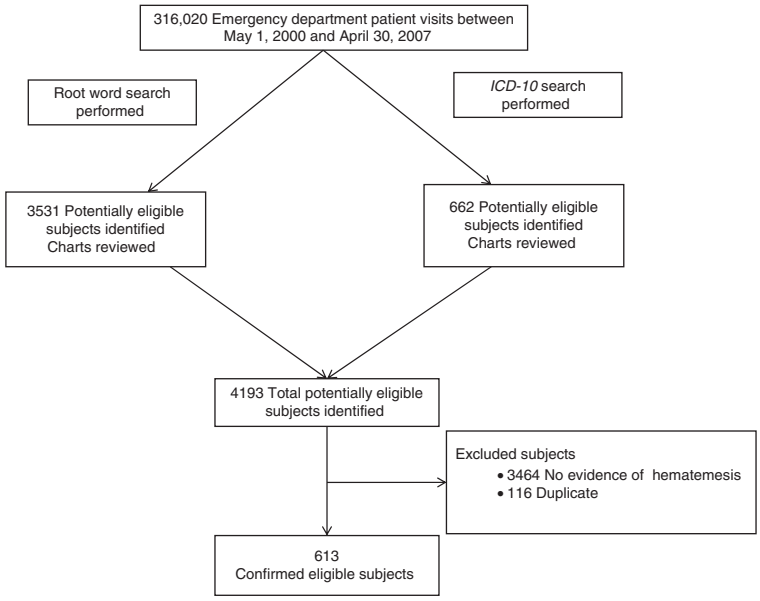

FIGURE 1. Summary of patient eligibility.

Children who had a clinically significant UGIH differed from those who did not (Table 2). Children with significant hemorrhages were older (median age 9.7 vs 2.9 years; $P < 0.001$), and they were more often associated with melena, a large volume of fresh blood in the vomitus, a significant medical history (Table 4), unwell appearance, and the presence of tachycardia (Table 2). The recent use of a medication that may predispose to gastrointestinal bleeding (eg, nonsteroidal anti-inflammatory drug [NSAID], steroids) was similar among children with and without significant UGIHs (4/27 [15%] vs 36/586 [6%]; $P = 0.09$).

Other Analyses

The frequency of laboratory investigations increased with patient age from 44% (179/410) in children younger than 5 years, to 59% (63/106) in children between 5 and 10 years of age, to 73% (71/97) in children older than 10 years ($P < 0.001$). A hemoglobin level was checked on 51% of eligible children (313/613), and the mean values differed statistically significantly between those with and without significant bleeds (Table 5). Only 4 children had the performance of a nasogastric lavage documented, and none of these children experienced a clinically significant bleed. The administration of a fluid bolus of $\geq$20 mL/kg of isotonic fluid was more common among children with a clinically significant gastrointestinal hemorrhage (4/27 [15%] vs 18/586 [3%]; $P = 0.01$). One hundred nineteen children (19%) were admitted to the hospital, the median length of stay was 85 hours (25%–75% percentile: 45–200), and a subsequent visit related to the index visit occurred in 39 children (5%). None received an alternative diagnosis at the revisit.

Medication administration also varied based on the presence of a major gastrointestinal hemorrhage. Those with significant hemorrhages were more likely to receive an acid-reducing agent (21/27 [78%] vs 96/586 [16%]; $P < 0.001$)—most commonly pantoprazole (Wyeth) (19/27 [70%] vs 35/586 [6%]); an antibiotic (5/27 [19%] vs 18/586 [3%]; $P = 0.002$); and (3) octreotide (Novartis Pharmaceuticals Basel, Switzerland) (7/27 [26%] vs 0/586 [0%]; $P < 0.001$).

The presence of any 1 of the following characteristics identified all 27 children with a clinically significant hemorrhage: melena, hematochezia, unwell appearance, or a moderate to large volume of fresh blood in the vomitus. The diagnostic test characteristics of having any 1 of these 4 features are sensitivity 100% (95% CI 84%–100%), specificity 72% (95% CI 68%–75%), positive predictive value 14% (95% CI 9%–20%), and negative predictive value 100% (95% CI 99%–100%). The likelihood ratios positive is 3.6 (95% CI 3.1%–4.1%). Applying these criteria to determine the need for testing would have reduced the number of children who underwent testing from 313 (51%) to 191 (31%).

Interobserver reliability was calculated for the 3 components of the primary outcome and the 4 variables that predicted its occurrence. The κ scores ranged from 1.0 (95% CI 0.93%–1.0%) for drop in hemoglobin >20 g/L, administration of a blood transfusion, interventional endoscopic or surgical procedure, presence of melena, hematochezia, and unwell appearance, to 0.81 (95% CI 0.75%–0.87%) for the classification as well/unwell. The volume of fresh blood in the vomitus, dichotomized as moderate/large versus minimal/small, had a κ of 0.84 (95% CI 0.78%–0.90%).

DISCUSSION

Our first objective was to identify the proportion of children, presenting for ED care with hematemesis, who are experiencing a clinically significant UGIH. We found that overall, hematemesis is an uncommon pediatric ED chief complaint. Moreover, only 4% of children with hematemesis evaluated in a tertiary care pediatric ED had a clinically significant UGIH. To our knowledge, there are no studies that specifically examine the proportion of children with clinically significant UGIH in this population. We also found that older children were at increased risk, and within our cohort, all of the significant cases could be identified by the presence of 1 of 4 factors: an unwell appearance, a history of melena, a history of hematochezia, or a large volume of fresh blood in the vomitus. These factors can help guide clinical decision making when evaluating a child with hematemesis.

TABLE 3. Final assigned diagnoses

	Clinically significant gastrointestinal hemorrhage, N = 27 (%)
Esophageal/gastric varices	7 (26)
Esophageal/gastric/duodenal ulcer	6 (22)
Esophagitis	3 (11)
Gastritis	2 (7)
Structural/mucosal abnormalities*	2 (7)
Thrombocytopenia	2 (7)
Esophageal abrasion	1 (4)
Gastroesophageal reflux disease	1 (4)
Acute surgical abdomen†	1 (4)
Naso-/oropharyngeal bleeding	1 (4)
Inflammatory bowel disease	1 (4)
	Clinically insignificant gastrointestinal hemorrhage, N = 586
Hematemesis	142 (24)
Swallowed maternal blood	82 (14)
Mallory-Weiss syndrome	75 (13)
Gastritis/esophagitis/ulcer	58 (10)
Viral intestinal infection	49 (8)
Acute upper respiratory infection	34 (6)
Epistaxis	32 (6)
Gastroesophageal reflux disease	29 (5)
Stomatitis/pharyngitis	25 (4)
Pneumonia/pertussis/sinusitis	12 (2)
Other‡	48 (8)

* Epidermolysis bullosa (1), lymphangioendothelioma (1).
† Malrotation with volvulus (1).
‡ Other includes reactive airways disease exacerbation (5), abdominal pain (4), coagulopathy (4), postoperation bleed (4), pyloric stenosis (4), sepsis (4), gastric/gastrojejunostomy tube bleed (4), constipation (3), inflammatory bowel disease (2), cyclic vomiting syndrome (2), foreign body (2), malignancy (1), allergic reaction (1), appendicitis (1), bowel obstruction (1), bronchiolitis (1), bulimia (1), drug ingestion (1), meningitis (1), seizure (1), and urinary tract infection (1).

The finding that significant UGIH is an infrequent occurrence is supported by pediatric intensive care unit (PICU) data reporting that only 2% of critically ill patients experienced an UGIH (14). Complications were rare with blood transfusions being administered to 63%, hypotension developing in 19%, and surgery being performed in 6%. The independent risk factors identified among the cohort of PICU patients included respiratory failure, coagulopathy, and a pediatric risk of mortality score $\geq$10.

We found that 63% of children with clinically significant UGIH had significant medical histories. This is in keeping with a previous North American study (19), but it is greater than what was reported in a nationwide study from France (7). In the latter study, only 19% of children had a medical risk factor for bleeding. This may reflect that our study was conducted at a tertiary care referral center that serves a large population of children with significant underlying disease. Alternatively, this may have been related to the definition of ''risk factor'' used because the authors of the aforementioned study restricted their list of risk factors to portal hypertension, history of upper gastrointestinal bleed or gastric or duodenal ulcer, gastroesophageal reflux, and coagulation disorders (7).

A total of 47% of children in a French cohort had taken at least 1 NSAID during the 4 weeks before their presentation, (7) whereas 56% did so in a retrospective case series from Turkey of children younger than 2 years (8). We found that only 9% of children had taken a medication potentially associated with gastrointestinal bleeding on the day of presentation. This frequency is similar to a published series of 231 children who underwent endoscopy for upper gastrointestinal bleeding that reported usage in 15% (20); however, this may be an underestimate resulting from the retrospective nature of our study and our reliance on documentation. Other possible explanations for these differences include the time frame evaluated (ie, 4-week window used by Grimaldi-Bensouda et al (7)), different etiological profiles of upper gastrointestinal bleeding in different countries (21,22), and the varying use of NSAIDs to treat pediatric illnesses (23). Although medication use was not associated with the occurrence of a significant UGIH in our study, an adjusted case-crossover design study that used caregiver self-assessment questionnaires found NSAID use to be a significant risk factor (adjusted odds ratio 8.2; 95% CI 2.6%–26.0%) (7). The latter study's conclusion, that NSAID exposure at recommended dosages is associated with gastrointestinal bleeding, should not be discounted.

Although we found the presence of a large volume of blood in the vomitus to be a predictor of a clinically significant UGIH, previous research has found the visual estimation of blood loss to be highly inaccurate, both by laypeople and by health care professionals (24). Parents overestimate blood volumes nearly three-fourths of the time and by a factor of 1.5 to 5 depending on the volume and mode of presentation. Doctors tend to underestimate blood loss (24–28), with nurses tending to be somewhat more accurate (24,25), however both of the latter groups tend to overestimate small volumes and underestimate larger ones (24), and these inaccuracies do not decrease with increasing experience (24–26,29). Despite these inaccuracies and the potential discrepancies that are inherent in chart reviews, we found a correlation between the perception of large volume and clinically significant UGIH.

Our findings highlight the role that history and clinical examination can play in identifying children at risk for a clinically significant UGIH. The variables that we have identified can be used to identify which children may require the performance of laboratory investigations. The baseline number of children undergoing testing at our institution (51%) may be lower than many other institutions because diagnostic testing was performed at the discretion of the responsible physician based on historical and clinical features. Should it be determined that investigations are warranted in a child without high risk features, then a complete blood count is the only test likely to yield clinically helpful information. Unfortunately, the performance of nasogastric lavage was infrequently documented in our cohort; hence, we cannot comment on its ability to determine the presence or volume of ongoing bleeding.

LIMITATIONS

The present study was retrospective, and not every episode of hematemesis was necessarily identified. Therefore, the data abstracted may be limited in terms of accuracy and completeness. For example, blood pressure and pulse oximetry were not included because they were often absent. This is in keeping with the standard practice in North American pediatric EDs—only 60% routinely measure blood pressure, and 41% pulse oximetry, at triage (30). Verification bias, also known as workup bias, referral bias, and selection bias, is another potential limitation. It occurs when

TABLE 4. Significant medical historical features among children included in the study cohort

	Clinically significant gastrointestinal hemorrhage, N = 27* (%)	Clinically insignificant gastrointestinal hemorrhage, N = 586 (%)	P†
Gastric/gastrojejunostomy tube, N	3 (11)	29 (5)	0.16
Known ulcer, N	3 (11)	7 (1)	0.008
Malignancy, N	2 (7)	7 (1)	0.06
Inflammatory bowel disease	2 (7)	2 (0.3)	0.01
Esophageal/gastric varices	2 (7)	0	0.002
Congenital heart disease, N	2 (7)	7 (1)	0.06
Earlier episode of hematemesis, N	1 (4)	29 (5)	1.0
GERD, N	1 (4)	21 (4)	1.0
Coagulopathy/platelet abnormality, N	1 (4)	9 (2)	0.37
Developmental delay	0	7 (1)	1.0
Tracheoesophageal fistula, N	0	5 (0.9)	1.0
Other*	0	18 (3)	1.0
None identified, N	10 (37)	445 (76)	<0.001

GERD = gastroesophageal reflux disease.
* Other features among children who did not have clinically significant upper gastrointestinal hemorrhages included bulimia (4), malrotation (4), esophagitis (2), hemangioma (2), immunosuppression (2), organ transplant (2), Hirschsprung disease (1), and Mallory-Weiss syndrome (1).
† *P* value of significance for this table is set at 0.004.

not all of the patients are equally likely to have the certain testing (clinical or laboratory) performed (31). In our cohort, not all of the children underwent all clinical (eg, blood pressure and pulse oximetry) and biochemical (eg, hemoglobin) tests. Physicians may have been more likely to order these tests (or document historical and examination clinical findings) for those children who were more likely to have a clinically significant UGIH. This may have created a bias, thereby overestimating the sensitivity of a diagnostic test (or clinical feature). Although a standard protocol was followed by the data abstractors, the documented findings may have been biased by the overall clinical presentation (ie, if a child was hemodynamically unstable, the physician may be more likely to document that the hematemesis was of a large volume or that the child looked unwell).

Additionally, although we assessed revisits to our institution, we did not use a provincial database to ensure that children did not represent to another ED; however, as the only tertiary care pediatric center with the only PICU in Toronto, it is unlikely that any child with a significant UGIH was hospitalized elsewhere. Although we had set out to perform a multivariate analysis to determine which clinical features were most strongly associated with the outcome, this was not feasible because of the limited number of cases identified.

CONCLUSIONS

In summary, 4% of children seen in a tertiary care pediatric ED with hematemesis have clinically significant UGIH. We did

TABLE 5. Laboratory investigations performed

	Clinically significant gastrointestinal hemorrhage, N = 27*		Clinically insignificant gastrointestinal hemorrhage, N = 586		
	No. tests done	Mean ± SD	No. tests done	Mean ± SD	P*
Hemoglobin, g/dL	27	10.1 ± 3.6	286	12.6 ± 2.1	<0.001
Platelet, $\times 10^3/\mu L$	25	256 ± 193	278	342 ± 138	0.004
Serum urea nitrogen, mg/dL	22	20.7 ± 13.5	226	14.6 ± 13.2	0.03
Partial thromboplastin time, s	18	30 ± 5	195	33 ± 8	0.08
International normalized ratio	18	1.1 ± 0.1	197	1.1 ± 0.3	0.47
Aspartate aminotransferase, IU/L	16	61 ± 53	116	43 ± 48	0.16
Alanine aminotransferase, IU/L	17	44 ± 34	115	35 ± 67	0.59

SI conversion factors: To convert hemoglobin to grams per deciliter, multiply by 10.0; platelet count to $\times 10^9$/L, multiply by 1; serum urea nitrogen to millimoles per liter, multiply by 0.357. SD = standard deviation.
* *P* value is comparing the mean results of the laboratory investigations between those who did and those who did not have a clinically significant gastrointestinal hemorrhage. *P* value of significance for this table is set at 0.007.

identify 4 features that in our cohort detected all of the children with significant UGIH: unwell appearance, history of melena, history of hematochezia, and a moderate to large volume of fresh blood in the vomitus. In addition, older age, a significant medical history, and the presence of tachycardia were independently associated with a clinically significant UGIH. Clinicians should consider these factors when evaluating children with a history of hematemesis to determine the need to perform investigations and administer therapeutic interventions.

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