CLINICAL REVIEW

Diagnosis and Management of Upper Gastrointestinal Bleeding in Children

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Upper gastrointestinal bleeding is an uncommon but potentially serious, life-threatening condition in children. Rapid assessment, stabilization, and resuscitation should precede all diagnostic modalities in unstable children. The diagnostic approach includes history, examination, laboratory evaluation, endoscopic procedures, and imaging studies. The clinician needs to determine carefully whether any blood or possible blood reported by a child or adult represents true upper gastrointestinal bleeding because most children with true upper gastrointestinal bleeding require admission to a pediatric intensive care unit. After the diagnosis is established, the physician should start a proton pump inhibitor or histamine 2 receptor antagonist in children with upper gastrointestinal bleeding. Consideration should also be given to the initiation of vasoactive drugs in all children in whom variceal bleeding is suspected. An endoscopy should be performed once the child is hemodynamically stable. (J Am Board Fam Med 2015; 28:134–145.)

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Upper gastrointestinal bleeding (UGIB) is an uncommon but potentially serious and life-threatening clinical condition in children. Anatomically, the upper gastrointestinal (GI) tract includes the esophagus to the ligament of Treitz; therefore UGIB includes bleeding that originates throughout this region. Common signs and symptoms at presentation include hematemesis (73%), melena (21%), and coffee-ground emesis (6%); however, patients may also experience epigastric pain, abdominal tenderness, or dizziness.[1–3]

The worldwide mortality rate for UGIB in children can range from 5% to 21%, which reflects the diverse populations that experience conditions associated with UGIB.[4,5] In the United States mortality is on the lower end of the spectrum as a result of improved pediatric intensive care, advances in diagnosis and treatment, as well as in the stabilization and management of critically ill patients. Mortality can be decreased by early identification of UGIB, and improved morbidity and mortality are most often the result of a multidisciplinary approach to care.[3] Among children admitted to pediatric intensive care units (PICUs), those with UGIB require more red blood cell transfusions, have longer hospital stays, and have a longer duration of mechanical ventilation.[6]

Literature Search

PubMed was searched in Clinical Queries using the key search terms *children or infants*, *gastrointestinal bleeding*, and *gastrointestinal hemorrhage*, *pathogenesis*, *diagnosis*, *and treatment*. The search included meta-analyses, randomized controlled trials, clinical trials, and reviews. We also searched Clinical Evidence, the Cochrane database, Essential Evidence Plus, the National Center for Biotechnology Information at the US National Library of Medicine, the National Guideline Clearinghouse, and DynaMed. Our initial search date was November 5, 2012, with follow-up searches preformed in December 2012, May 2013, and February 2014.

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Epidemiology

In a case-crossover study conducted in France, the incidence of UGIB in children was 1 to 2 in 10,000 per year.[7] This study showed a female-to-male ratio of 1.2:1, and symptoms of hematemesis were present in 96.6%, melena in 14.1%, and hemorrhagic shock in 2.8%.[7] Among the population in this study, 11.3% had a personal history of ulcer or prior UGIB, 5.7% had portal hypertension, and 8.5% had a relevant medical history, for example, a coagulation disorder or rheumatoid purpura.[7] A total of 20 patients (11.3%) in this study required transfusion.[7] The incidence of significant UGIB in children admitted to the PICU has been reported to be 0.4% to 1.6%.[8] A prospective comparative study conducted in a PICU in a tertiary care, university-based facility in the United States found a 25% prevalence of UGIB.[5] The overall mortality of patients in this study was 4.8%, with a significantly higher mortality seen in patients with UGIB than in those without (16% vs 1.3%; $P = .0001$).[5] A prospective Canadian study conducted in a PICU within a university hospital, detected UGIB in 63 of 984 children (6.4%), but only 0.4% had a clinically significant outcome, for example, hypotension, death, or transfusion occurring within 24 hours after the bleeding episode.[9] In this study 43% were female and their mean age was 5.3 years.[9] The highest frequency of developing UGIB (69.8%) occurred within the first 72 hours of admission to the PICU.[9]

Causes

The causes of UGIB can be categorized by age groups. In newborns the predominant causes include coagulation disorders such as vitamin K deficiency, cow milk intolerance, gastritis from stress, sepsis, and trauma from the placement of nasogastric tubes.[10] From 1 month to 1 year of age, the most prevalent causes are caustic ingestions, duplication cysts, foreign body ingestion, stress esophagitis, medication-induced bleeding (eg, nonsteroidal anti-inflammatory drug [NSAID] use), and peptic ulcer bleeding.[10] From 1 to 5 years of age, causes include erosive esophagitis, gastritis, caustic ingestions, peptic ulcer bleeding, varices, and vomiting-induced bleeding, for example, from a Mallory-Weiss tear.[10] From ages 5 to 18 years, bleeding can arise from coagulation disorders, gastritis, Dieulafoy lesions (an anomalous artery located in the digestive tract), erosive esophagitis, peptic ulcer disease, caustic ingestions, and vomiting-induced bleeding.[10] Crohn's disease is an uncommon cause of UGIB in children and adolescents.[11,12] Certain foods may create confusion for children and parents by mimicking the appearance of blood in vomitus (eg, red food coloring, fruit-flavored drinks, fruit juices, and beets) or by mimicking the appearance of melena in stools (eg, iron, grape juice, spinach, or blueberries).[11,12] All suspicious findings consistent with blood should be investigated further.

Globally, the etiology of UGIB differs significantly based on variations in patient population and the presence of comorbid conditions.[1] In the Middle East and Asia, the causes of UGIB include peptic ulcer bleeding (24%), varices secondary to viral hepatitis (23%), erosive esophagitis (0.2%), and vomiting-induced hematemesis (0.2%).[1] In North and South America, peptic ulcer bleeding (44%), varices (11%), vomiting-induced hematemesis (1.2%), and erosive esophagitis (0.6%) comprise the majority of UGIB cases.[1]

Risk Factors

Risk factors for UGIB vary. NSAID use and *Helicobacter pylori* infection should be considered in children with severe UGIB. The observed risk of UGIB with NSAIDs is 7.2 per 100,000, based on a study of 55,785 children.[13] The risk of developing UGIB with NSAID use is greater in the 2-month-old to 7-year-old age group (odds ratio [OR], 14.1) versus the 8- to 16-year-old age group (OR, 3.4).[7] *H. pylori* has been found in up to 49% (41 of 84) of children presenting with UGIB.[14] This infection represents an important risk factor, especially in children with hereditary hemorrhagic disorders such as hemophilia[15] (Table 1). Other risk factors include peptic ulcer disease, portal hypertension or varices, and bleeding disorders.[3] Children who require mechanical ventilation during the course of their hospitalization have a higher incidence of UGIB if they also experience a high pressure ventilator setting (relative risk, 3.73) or organ failure (relative risk, 2.85).[20] Other risk factors include trauma (OR, 20.9), shock (OR, 17.4), and operative procedures >3 hours long (OR, 3.6).[5]

Associated Conditions

Multiple disorders can contribute to the development of an UGIB in pediatric patients. Hemato-

Table 1. *Helicobacter pylori* Testing[16–19]

Test	Endoscopic versus Nonendoscopic	Normal Result	Comment
Culture	Endoscopic	No growth	Expensive and not widely available
Fecal antigen test	Nonendoscopic	No antigen detected	Useful before and after therapy; identifies active *H. pylori*
Histologic biopsy	Endoscopic	No *H. pylori* identified	Highly sensitive and specific
Polymerase chain reaction	Endoscopic	No *H. pylori* identified	Not widely available
Quantitative and qualitative antibody testing	Nonendoscopic	Negative	Not recommended after therapy
Rapid urease test	Endoscopic	Negative	Sensitivity reduced in patients after treatment
Urea breath test with ^{13}C and ^{14}C	Nonendoscopic	Negative	Useful before and after therapy

logic disorders, such as hemophilia A and B and Von Willebrand disease, predispose patients to UGIB secondary to the increased risk of bleeding mucosal membranes.[15] Conditions such as biliary atresia, portal vein thrombosis, primary sclerosing cholangitis, autoimmune hepatitis, Budd-Chiari syndrome, and cystic fibrosis predispose patients to UGIB through the development of portal hypertension, which can lead to the formation of varices, a known cause of UGIB.[21]

Screening and Prevention

There are no guideline-based screening or prevention recommendations. However, screening endoscopy is recommended for patients with conditions that have a high incidence of portal hypertension in an effort to identify variceal formation as early as possible.[22] Endoscopic findings of red markings or gastric varices are of concern for the presence or future development of UGIB.[3] Children who have been diagnosed with esophageal varices, red markings, or gastric varices on initial screening endoscopy should undergo endoscopic sclerotherapy or band ligation to prevent hemorrhage.[22] In addition, the use of β-blockers in at-risk children is recommended as prophylaxis for variceal bleeding.[23] Children in a PICU should be considered for prophylaxis with histamine 2 receptor antagonists or proton pump inhibitors.[24]

Diagnosis

There are no randomized controlled trials, Cochrane reviews, or systematic reviews of the diagnostic approach in children with UGIB. The diagnostic approach is mostly extrapolated from studies of adults; the key points are an extensive history and examination, laboratory evaluations, and diagnostic procedures.

Differential Diagnosis

The differential diagnosis for UGIB includes causes for lower GI bleeding (LGIB), non-GI sources, ingested maternal blood, or food sources imitating hematemesis or melena. Causes of LGIB include conditions such as Crohn's disease, ulcerative colitis, hemorrhoids, anal fissures, and Meckel diverticulum. Non-GI sources of bleeding include epistaxis or hemoptysis that may present with symptoms similar to those of UGIB, such as hematemesis, melena, and positive occult blood tests (Table 2). Maternal sources include ingestion of blood during delivery or from cracked nipples during breastfeeding; infants who ingest maternal blood may present with hematemesis or melena.[10]

History

Children with a history of concurrent major illness that require PICU care, such as sepsis and respiratory failure, may present with stress gastritis or stress ulcers.[3] Indications for possible variceal bleeding include a history of autoimmune hepatitis, Budd-Chiari syndrome, cystic fibrosis, biliary atresia, portal vein thrombosis, or primary sclerosing cholangitis.[22] Family history should be assessed for inheritable diseases that may increase risk for UGIB, for example, liver disease, any history of requirements for clotting factor replacement, hemophilia A, hemophilia B, and Von Willebrand disease.[15]

Defining the amount of bleeding and any associated symptoms is important. If the patient is

Table 2. Associated Etiologies of Upper Gastrointestinal Bleeding, By Age[10,12,25]

Age Group	Etiology
Neonate	Swallowed maternal blood
	Gastritis
	Necrotizing enterocolitis
	Coagulopathy in the presence of infection
	Congenital coagulation deficiency
	Esophagitis
	Vascular malformation
	Hemorrhagic disease of the newborn
	Idiopathic
1 Month-1 year	Peptic ulceration
	Curling ulcer
	Duplication cyst
	Foreign body
	Gastric or esophageal varices
	Vascular malformation
	Bowel obstruction
	Epistaxis
	Hemoptysis
	Reflux esophagitis
	Stress gastritis
	Medication-induced gastritis (eg, NSAIDs or aspirin use)
	Caustic ingestion
1–5 Years	Peptic ulceration
	Stress gastritis
	Medication-induced gastritis (eg, NSAIDs or aspirin use)
	Varices
	Epistaxis
	Hemoptysis
	Mallory-Weiss tear
	Gastroesophageal reflux
	Caustic ingestion
	Bowel obstruction
	Vasculitis
	Crohn disease
	Hemophilia
5–18 Years	Varices
	Peptic ulceration
	Coagulation disorders
	Immune thrombocytopenic purpura
	Chemotherapy
	Crohn disease
	H. pylori gastritis
	Gastroesophageal reflux
	Mallory-Weiss tear
	Caustic ingestion

NSAID, nonsteroidal anti-inflammatory drug.

Table 3. Normal Vital Signs According to Age[8]

Age	Heart Rate (beats/min)	Respiratory Rate (breaths/min)
Newborn	120–160	30–60
1–6 Months	120–150	30–50
7–12 Months	110–140	25–40
1–3 Years	90–130	20–30
4–5 Years	85–120	20–25
6–12 Years	70–100	16–22
13–18 Years	60–80	12–18

able to subjectively report symptoms, he or she should be assessed for abdominal pain, dizziness, shortness of breath, and palpitations. Signs and symptoms that increase suspicion of UGIB include abdominal or chest pain, coffee ground–like emesis, black tarry stools, bright red blood from the rectum, or hematemesis.[3] The stool color may be helpful to differentiate UGIB from LGIB. Maroon stools or frank blood from the rectum may signal rapid UGIB.[25] In children significant blood loss may occur before tachycardia, hypotension, or tachypnea are observed; for example, slow bleeding may result in a loss of 13% of total blood volume with no change in hemodynamic status.[25] Furthermore, a loss of palmar crease with wrist hyperextension may indicate a >50% loss of blood volume.[25]

A comprehensive review of medications should be performed, with a special focus on those medications that may increase the risk of UGIB. These include aspirin, NSAIDs, corticosteroids, and selective serotonin reuptake inhibitors (SSRIs).[3] NSAIDs increase the risk of UGIB by damaging gastric mucosa and promoting tissue friability.[26] The greatest risk of devel-

Table 4. Normal Systolic Blood Pressure According to Age[8]

	Systolic Blood Pressure (mmHg)*	
Age	Normal	Lower Limit
0–1 Month	>60	50
1–12 Months	>80	70
1–10 Years	90 + (2 × age in years)	70 + (2 × age in years)
>10 Years	110–130	90

*Diastolic blood pressure = 0.5 − 0.66 × systolic blood pressure.

Table 5. Laboratory Tests in the Workup of Upper Gastrointestinal Bleeding in Children[1,29–31]

Test	Description	Normal Results			Comments
Complete blood count	Peripheral whole-blood sample for hemoglobin, hematocrit, and platelets	Age	Values in Males (g/dL)	Values in Females (g/dL)	Requirement for transfusion is based on a patient's underlying illness and overall clinical presentation. Ranges may vary by institution or laboratory.
		Newborn	13–22	13–22	
		1–24 Months	9.5–14	9.5–14	
		2–10 Years	11.5–14.5	11.5–14.5	
		10–17 Years	12.5–16.1	12–15	
		Adults	13.5–18	12.5–16	
		Hemoglobin:			
		Age	Values in Males (%)	Values in Females (%)	
		Newborn	45–67	45–67	
		1–2 Months	31–55	31–55	
		2–3 Months	28–42	28–42	
		3–6 Months	29–41	29–41	
		6–24 Months	33–39	33–39	
		2–10 Years	34–45	34–45	
		10–17 Years	37–49	37–49	
		Adult	41–53	36–46	
		Hematocrit:			
		Age	Values in Males (g/dL)	Values in Females (g/dL)	
		Newborn to adult	140–450 × 10^9/L	140–450 × 10^9/L	
		Platelets:			
Chemistry profile		Age (Years)	Values in Males (U/L)	Values in Females (U/L)	Elevated liver enzymes may indicate underlying liver disease.
		0–5	35–140	20–93	
		6–3	20–60	20–93	
		4–6	15–50	16–61	
		7–9	14–40	15–40	
		10–11	10–60	10–40	
		12–15	15–40	5–30	
		Aspartate transaminase:			
		Age	Values in Males (U/L)	Values in Females (U/L)	
		1–7 Days	20–54	21–54	
		8–30 Days	24–54	22–46	
		1–3 Months	27–54	26–61	
		4–6 Months	27–54	26–61	
		7–12 Months	26–59	26–55	
		1–3 Years	19–59	24–59	
		4–6 Years	24–49	24–49	
		10–11 Years	24–49	24–44	
		12–13 Years	24–68	24–44	
		14–15 Years	24–59	19–44	
		16–19 Years	24–54	19–49	

Continued

Table 5. Continued

Test	Description	Normal Results	Comments
		Alanine aminotransferase:	
		Age / Values in Males (U/L) / Values in Females (U/L) 1–30 Days: 16–450 / 16–450 1–3 Months: 16–267 / 16–267 3–5 Months: 16–167 / 16–167 5–8 Months: 8–84 / 8–84 9 Months to 17 years: 5–55 / 5–55 >17 Years: 15–85 / 5–55	
		γ-Glutamyl-transferase:	
		Age / Values in Males (mg/dL) / Values in Females (mg/dL) 1 Month to adult: 0.2–1.2 / 0.2–1.2	
		Total bilirubin:	
		Age / Values in Males (mg/dL) / Values in Females (mg/dL) 0–3 Days: 0.2–1 / 0.2–1 4 Days to 2 years: 0.2–0.5 / 0.2–0.6 2–4 Years: 0.3–0.6 / 0.2–0.7 5–7 Years: 0.2–0.7 / 0.2–0.8 8–10 Years: 0.3–0.8 / 0.3–0.9 11–12 Years: 0.3–0.9 / 0.3–1 13–17 Years: 0.3–1.1 / 0.3–1.2 >17 Years: 0.3–1.1 / 0.5–1.3	A BUN-to-creatinine ratio >30 has excellent specificity (98%) and good sensitivity (68.8%) for UGIB.
		Creatinine:	
		Age / Values in Males (mg/dL) / Values in Females (mg/dL) 0 Days to adult: 6–17 / 6–17	
		BUN:	
Coagulation studies	Venous sample from citrated tube for PT/INR, PTT	PT: 11–15 sec INR: 1 PTT: 25–35 sec	Prolonged PT/INR or PTT may indicate preexisting coagulopathy, liver dysfunction, or acute illness such as sepsis or disseminated intravascular coagulation.

BUN, blood urea nitrogen; INR, international normalized ratio; PT, prothrombin time; PTT, partial thromboplastin time; UGIB, upper gastrointestinal bleeding.

oping gastric complications typically occurs within 30 days of initiating NSAID therapy.[26] SSRIs inhibit platelet aggregation, and the concurrent use of NSAIDs and SSRIs further increases the risk for UGIB.[27] In addition, corticosteroid use in neonates has been associated with increased mortality from GI hemorrhage.[28] One study found high-dose dexamethasone used in the treatment of ventilator-dependent premature infants was associated with major complica-

Table 6. Ancillary Tests in the Workup of Upper Gastrointestinal Bleeding in Children[1,12,29,31,33]

Test	Description	Normal Result	Comments
Angiography	Arterial contrast study	No extravascular extravasation of dye	Has an overall good diagnostic rate of 64% but has better diagnostic accuracy in acute UGIB (71%) compared with chronic or recurrent UGIB (55%).
Apt-Downing test	Stool specimen from neonate	Negative	Important to distinguish between maternal and neonatal blood.
Endoscopy	Fiber-optic visualization of esophageal, gastric, and duodenal mucosa	No bleeding sites noted; no varices	Urgent endoscopy is indicated for bleeding requiring transfusion or hemodynamic instability; otherwise endoscopy can be performed within the first 24 hours of admission.
Gastric aspirate	Aspirate from nasogastric tube	No blood detected	Place nasogastric tube for gastric lavage to improve the accuracy of endoscopy. Consider testing gastric aspirate for occult blood using Gastrocult (Beckman Coulter, Inc., Palo Alto, CA).
Stool for occult/frank blood (eg, hemoccult)	Stool specimen from rectal examination	Negative	Alpha guaiaconic acid reacts with hydrogen peroxide in the presence of heme and produces a blue quinone compound. This denotes a positive test.

UGIB, upper gastrointestinal bleeding.

tions, such as perforated gastric ulcers, duodenal ulcers, and upper GI hemorrhage.[28] That 5-year review found a 66% mortality rate among children who received high-dose dexamethasone and subsequently developed a GI complication.[28]

Physical Examination

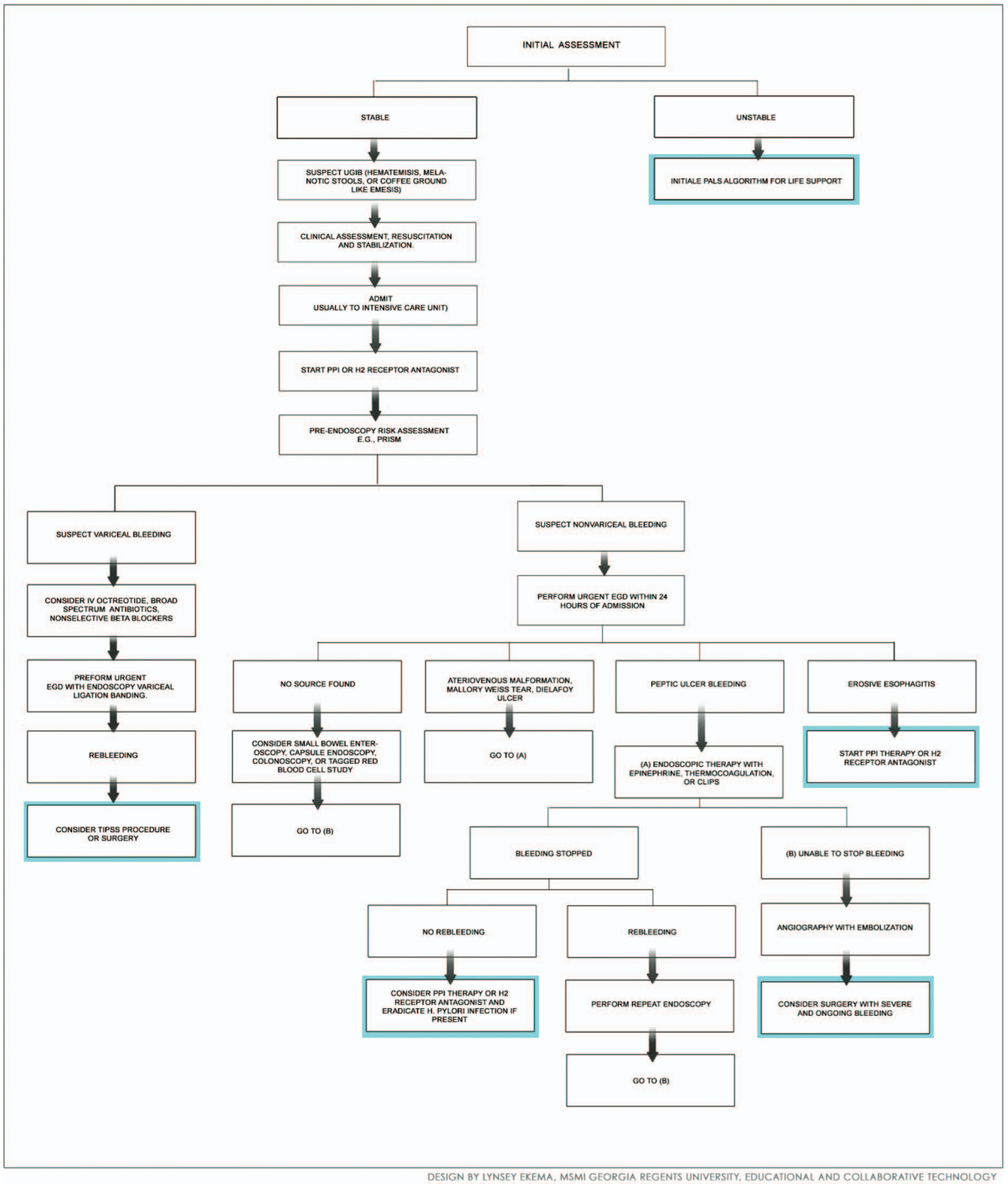
Airway, breathing, and circulation should be assessed to evaluate hemodynamic stability. Vital signs should be monitored for tachycardia, tachypnea, hypotension, orthostatic hypotension, and capillary refill (Tables 3 and 4). Tachycardia is the most sensitive indicator for blood loss in children.[8] General presentation should be noted, including confusion, irritability, and respiratory distress. Ecchymosis may signal a poorly controlled bleeding disorder or trauma. Pallor may indicate severe blood loss but may not be present in an acute UGIB. The abdomen should be assessed for guarding, epigastric or rebound tenderness, surgical scars, hepatomegaly, right upper quadrant tenderness, or other signs or sequelae of chronic liver

Table 7. Key Recommendations

Recommendation	SORT†	Reference
Consider repeat esophagogastroduodenoscopy in children with either ongoing UGIB or rebleeding	C	28
Distinguish between variceal and nonvariceal bleeding	C	8
Initiate proton pump inhibitors or histamine 2 receptor antagonist in children with suspected UGIB	C	8
Stabilize children with UGIB before diagnostic testing	C	8
Complete urgent esophagogastroduodenoscopy as the diagnostic procedure of choice in children with suspected UGIB	C	28

†Strength of recommendation taxonomy (SORT) taken from ref. 47.
UGIB, upper gastrointestinal bleeding.

Figure 1. Algorithm for the approach to treating a child with upper gastrointestinal bleeding. EGD, esophagogastroduodenoscopy; H2, histamine 2; IV, intravenous; PALS, pediatric advanced life support; PPI, proton pump inhibitor; PRISM, pediatric physiology-based score for mortality.



disease.[11] The evaluation should also include a rectal examination to identify any hemorrhoids or fissures that may indicate a lower GI source of bleeding. A stool sample should be obtained for occult blood testing (eg, hemoccult).[11]

Diagnostic Testing

Blood should be obtained to measure hemoglobin, hematocrit, blood urea nitrogen, creatinine, platelet count, prothrombin and partial thromboplastin times, international normalized ratio, liver enzymes

Table 8. Pharmacologic Therapies in the Treatment of Upper Gastrointestinal Bleeding[11,37–40]

Name	Dosage	Indication	Contraindication	Comments
Fluid resuscitation	Lactated Ringers or normal saline: 20 mL/kg boluses for <5 min, for total of 80 mL/kg in the first 20 minutes; in patients with cardiac insufficiency, dose 5–10 mL/kg bolus	Hemodynamic instability	Congestive heart failure	Obtain 2 large-bore IV lines. Place a Foley catheter to monitor urine output. If poor response, use crystalloid solutions; consider colloid solutions, such as albumin or plasma, and place intraosseous access immediately.
Proton pump inhibitors	Omeprazole: 1 mg/kg/24 hr by mouth in 1 or 2 divided doses or IV once daily; reported effective range: 0.2–3.5 mg/kg/24 hours	Duodenal or gastric ulcer; stress gastritis Prophylaxis is an off-label indication	Drug hypersensitivity	Children 1–6 years old may require higher doses because of enhanced drug clearance. PPIs have a longer duration of action than H2 receptor antagonists. Limited safety and efficacy information in children. Duration of therapy is unknown.
H2 receptor antagonist	Ranitidine: Oral: 2–4 mg/kg BID IV or IM: 2–4 mg/kg/day divided and administered every 6–8 hours Maximum dose: 50 mg every 6–8 hours	Duodenal or gastric ulcer; stress gastritis Prophylaxis is an off-label indication	No absolute contraindications	Duration of therapy is unknown.
Vasoactive drug	Octreotide: 1 μg/kg IV bolus, followed by infusion 1to 2 μg/kg/hour	Variceal bleeding is an off-label indication	No absolute contraindications	No randomized controlled trials on use in children
β-Blockers	Propranolol: Oral: 0.5–2 mg/kg/day in 2–4 divided doses, with the goal of reducing heart rate to 75% of baseline	Portal hypertension and esophageal varices are an off-label indications	Asthma, atrioventricular block, bradycardia, cardiogenic shock, sick sinus syndrome	A meta-analysis found that combining endoscopic therapy and β-blockers reduced overall rebleeding more than endoscopic therapy alone or β-blocker use alone in patients with cirrhosis and bleeding esophageal varices.

BID, twice a day; H2, histamine 2; IM, intramuscular; IV, intravenous; PPI, proton pump inhibitor.

(eg, aspartate transaminase and alanine aminotransferase), and type and crossmatch[8] (Table 5). In newborns with suspected UGIB, an Apt test can differentiate neonatal blood from maternal blood.[29] A blood urea nitrogen—to–creatinine ratio >30 may be helpful to distinguish UGIB from LGIB (specificity, 98%; sensitivity, 69%; likelihood ratio, +34.4 and −0.32, respectively).[30] Placing a nasogastric tube for gastric lavage can improve the accuracy of endoscopy.[11] In addition, gastric aspirate can be assessed for occult blood using a Gastroccult (Beckman Coulter, Inc., Palo Alto, CA).[32] Stool specimens should be obtained to evaluate the presence of heme using hemoccult testing; however, hemoccult is not accurate in testing for blood in gastric aspirate because of the pH of gastric contents.[11,12] Undercooked meats and raw fruits or vegetables may create false-positive hemoccult results; therefore a positive hemoccult result warrants investigation.[11,12]

Urgent endoscopy, which is performed <12 hours after admission, is indicated for bleeding that requires transfusion or for hemodynamic instability; otherwise, endoscopy can be performed within the first 24 hours of admission[8] (Tables 6 and 7). The reported efficacy of endoscopy for controlling UGIB is approximately 90%.[34] There are no randomized controlled trials or systematic reviews of follow-up endoscopy in children with significant UGIB. Based on

Table 9. Nondrug Therapies for Upper Gastrointestinal Bleeding in Children[41–46]

Name	Description	Indications	Complications
Injection therapy	Injection of solutions including hypertonic saline with epinephrine, normal saline with epinephrine, thrombin in normal saline, and ethanol	Variceal and nonvariceal bleeding	Tachycardia, cardiac arrhythmias, hypertension
Thermocoagulation	Heater probe; monopolar, bipolar, and multipolar coagulators	Variceal and nonvariceal bleeding	Heat-related mucosal injury, bleeding, or perforation May have delayed hemorrhage from site of therapy for up to 4 weeks
Laser photocoagulation	Argon and neodymium: yttrium-aluminum-garnet lasers	Variceal and nonvariceal bleeding	Very expensive equipment; not widely used outside of specialized endoscopy centers
Hemostatic clips	Endoscopically placed clips that are deployed at the site of the bleed	Variceal and nonvariceal bleeding	Bleeding and perforation; clips can migrate off site of bleed, although rarely
Endoscopic band ligation	Use of elastic bands on bleeding lesion	Variceal bleeding and Dieulafoy lesions	Postprocedural pain, ulceration, secondary hemorrhage Retrospective study stated that 27% of patients had rebleeding after band ligation and 1% had esophageal perforation
Adhesive closure with N-butyl-cyanoacrylate	Injection of tissue adhesive	Variceal bleeding, especially for gastric varices	Rebleeding, sepsis, arterial embolization (rare)
Transjugular intrahepatic portosystemic shunt	Tract created within the liver using radiographic guidance to connect 2 veins	Biliary atresia, variceal bleeding	Limited data and experience in children
Surgical shunt placement	Attachment of autologous or synthetic vein to vein	Bleeding is uncontrolled by therapeutic endoscopy and angiography	Loss of shunt patency, repeat procedures
Balloon tamponade	Balloon inflated at the site of bleeding	Uncontrolled UGIB	Limited experience in children; should not be used for more than 24 hours

UGIB, upper gastrointestinal bleeding.

adult studies, repeat endoscopy in children with life-threatening UGIB should be considered within 48 to 72 hours after the initial endoscopy.[34] In children with severe peptic ulcer bleeding, follow-up endoscopy may be considered within 4 to 6 weeks to assess ulcer healing.[8]

Treatment

There are no randomized controlled trials or systematic reviews of the therapeutic approach to children with UGIB. Although many pediatric patients present with UGIB that is not hemodynamically significant, rapid assessment, stabilization, and resuscitation should precede diagnostic evaluation in unstable children. This includes assessment of the airway, breathing, and circulation.[8] Patients with active bleeding that leads to hemodynamic compromise require intravenous access for fluid resuscitation and transfusion, as well as cardiopulmonary and urine output monitoring; they may also require intubation and mechanical ventilation for airway protection.[8] Patients requiring emergent measures for survival should be transferred to a PICU (Figure 1). The pediatric physiology-based score for mortality (PRISM) can be used to assess the risk of mortality by taking clinical parameters and laboratory values into consideration.[29] A score >10 (OR, 13.4) has been shown to be clinically significant for elevated mortality in the pediatric population.[36]

Blood transfusion is appropriate for unstable patients and those with hemoglobin ≤8 g/dL.[8] The amount of blood transfused should be determined according to age and weight.[8] Children with active bleeding and coagulopathy should be considered

for transfusion with fresh frozen plasma; those with thrombocytopenia should also be considered for platelet replacement, particularly when platelet count is <30,000.[8] Considering starting a proton pump inhibitor, for example, omeprazole, in all children with UGIB is reasonable.[8,24] Vasoactive drugs (eg, octreotide or vasopressin, broad-spectrum antibiotics, and nonselective β-blockers) can be added in children who are suspected of having variceal bleeding[8] (Tables 8 and 9). Octreotide is preferred over vasopressin because it has improved efficacy and fewer side effects.[34] Cytoprotective agents such as sucralfate and misoprostol have no role in the treatment of clinically significant UGIB in children.

A multidisciplinary team in a tertiary care center may be necessary to evaluate and manage children with UGIB. Consultation with pediatric intensivists, gastroenterologists, anesthesiologists, and surgeons may be required for patients with life-threatening bleeding.[3] Endoscopic treatments include the application of clips, coagulation, banding, injection, sclerotherapy, and the use of tissue adhesives.[8] A pediatric interventional radiologist or other specialist is needed if angiography is indicated when endoscopic therapy is unsuccessful.[34] Children with bleeding that is not controlled with endoscopic or angiographic interventions should be evaluated for surgery[34] (Figure 1).

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