Gastrointestinal bleeding in infants and children

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Gastrointestinal (GI) bleeding in infants and children is an alarming symptom to both the patient and parents. It can present orally and/or rectally. While minor GI bleeding is usually a self-limited condition, requiring only minimal intervention, it can certainly be a life-threatening condition at times. An initial focused review of the history and physical examination, followed by a detailed history, investigations and management, is necessary to identify the etiology of the bleeding and aid in its treatment. This article reviews the different etiologies, investigation and therapeutic options for management of GI bleeding in infants and children.

Keywords: children, gastrointestinal bleeding, hematemesis, hematochezia, infants, melena

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Gastrointestinal (GI) bleeding can be occult or overt. Occult bleeding presents with fatigue, iron-deficiency anemia, or is identified when stool is tested in a child with other symptoms, such as abdominal pain or vomiting. However, overt bleeding can be frightening. Overt GI bleeding can manifest either as vomiting gross blood or coffee-ground material (hematemesis), or *per rectum,* as passage of either bright red gross blood, dark red blood (hematochezia) or black tarry stools (melena). The bleeding is considered to be of the upper GI tract in origin if it is proximal to the ligament of Treitz, and lower GI bleeding if it is distal to it.

Is it blood or not blood?

Evaluation by the emergency physician begins with a quick assessment of the patient to decide the level and urgency of the intervention. An important consideration is to make sure that what appears to be blood, really is blood. Certain foods and medications can certainly alter the color of the emesis or stool, and even an experienced individual could mistake this for blood and prompt unnecessary investigations in a child. Substances that may give red color to stool or vomitus include ingested red candies, fruit punch, beets and medications such as rifampin, whereas black color could be from bismuth, iron, charcoal and foods such as spinach and blueberries [1]. Hence, it is important to test the emesis or stool for blood. Stool or vomitus is tested for blood by using the widely available guaiac test, which changes color in the presence of hemoglobin. The newer Hemoccult® ICT is an immunochemical test that is more specific, with fewer false-positive results [101]. Emesis should be tested with a test kit for gastric fluid (e.g., Gastroccult®), because they are more reliable in acidic pH [2,102]. Once it has been determined that it is blood, the further management is decided. Early consultation with a pediatric gastroenterologist, either in the emergency department or after admission to the hospital, should be considered for a child with significant bleeding, which is defined as: the presence of large clots in the emesis or stool, in addition to melena; a drop of hematocrit by more than 10%; or tachycardia, diaphoresis, orthostatic changes or any suggestion of portal hypertension or liver disease. However, they should also have carried out a quick assessment of symptoms, such as abdominal pain, weight loss or jaundice, and also be aware of any significant family history, such as inflammatory bowel disease in a hospitalized child. Less severe cases of bleeding, including suspected polyps, or occult GI bleeding can be evaluated in an outpatient setting.

Differentiation of upper versus lower GI bleeding

In most cases, the clinical presentation helps to determine the site of bleeding. In a child presenting with hematemesis, the source of bleeding is in the upper GI tract, even though it certainly can represent swallowed blood – as in newborns with swallowed maternal blood, or swallowed blood in a child with epistaxis. In children presenting with bright red blood in the stool or bloody diarrhea, the source of bleeding is usually the lower GI tract, most likely the colon. Rarely, massive upper GI bleeding can present with hematochezia.

Differential diagnoses

It would be appropriate to consider the differential diagnoses of GI bleeding, depending on the presentation and age of the patient (**Boxes 1–4**). Different etiologies cause bleeding at different ages in children, from newborn to adolescents. In a

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healthy-appearing newborn or breast-fed young infant who presents with hematemesis, swallowed maternal blood is a strong possibility, and this can be differentiated by the Apt–Downey test, since fetal hemoglobin is alkali resistant [3].

In patients who present with hematemesis, a history of heartburn, chest pain, epigastric pain or frequent regurgitation may suggest erosive esophagitis or peptic ulcer disease. A history of liver disease, such as biliary atresia, could point towards variceal bleeding. A history of forceful retching and vomiting preceding the hematemesis could be due to Mallory–Weiss tear, which is a mucosal laceration at the gastroesophageal junction, or gastric cardia. NSAID-induced gastritis can be an important cause of hematemesis [4].

Patients in intensive care units may develop hematemesis from hemorrhagic stress gastritis or ulcerations from nasogastric (NG) tube suctioning or other trauma. Bleeding associated with severe abdominal pain with rash of the lower extremities may signal Henoch–Schonlein purpura [5].

The differential diagnoses of rectal bleeding depend on the character of blood, age of the patient, and other associated symptoms. The blood from the upper GI tract certainly can present as melena or hematochezia depending on the magnitude of bleeding, at times without hematemesis. The painless, intermittent rectal bleeding could be from colonic polyps, but such a presentation with massive bleeding is more likely due to bleeding from an ulcerated Meckel's diverticulum [1]. In a younger child who presents with intermittent crying, lethargy and vomiting with acute hematochezia, it may suggest intussusception. Vomiting, frequently bilious, with rectal bleeding suggests mid-gut volvulus from malrotation. A child who presents with diarrhea and rectal bleeding may have colitis of infectious etiology, or as a result of inflammatory bowel disease. Rectal bleeding is a frequent presentation of allergic colitis from milk-protein intolerance in infancy [1].

Box 1. Causes of hematemesis.

- Swallowed blood: especially in newborns, swallowed maternal blood – Epistaxis, following tonsillectomy, breast feeding
- Erosive esophagitis: either reflux related or other causes of esophagitis
- Esophageal varices
- Mallory–Weiss tear
- Prolapse of the gastroesophageal junction
- Gastritis, including *Helicobacter pylori* gastritis, NSAIDs, caustic ingestion, graft-versus-host disease
- Gastric ulcers: patients in intensive care units, severe burns, Crohn's disease
- Eosinophilic gastroenteritis
- Peptic ulcer disease
- Vasculitis; Henoch–Schonlein purpura
- Variceal bleeding from gastric varices
- Vascular malformations
- Coagulation disorders; platelet dysfunction
- Trauma, including nasogastric tube suctioning
- Gastrointestinal stromal tumors
- Hemobilia
- Upper gastrointestinal tract duplication

Initial evaluation

A rapid assessment of the bleeding child is mandatory, and the following questions need to be answered:

- Is the child stable?
- Is it significant bleeding?
- Is the child actively bleeding now?
- Is there a known condition that makes this child susceptible to bleeding?

History is very essential in the evaluation of a bleeding child. The source of bleeding, extent or magnitude of the bleeding, duration of bleeding and associated symptoms should be sought from the caregiver and the child, if possible, as well as from any person who witnessed the event. A history of bleeding disorders, liver disease, GI diseases and ingestion of medications, especially NSAIDs, alcohol or recent antibiotic use, would be critical in the initial evaluation. In a stable child, detailed history and review of systems can be obtained prior to initiating management. In a seriously ill child with evidence of significant bleeding, such as lethargy, pallor, diaphoresis, dizziness or orthostatic changes in heart rate or blood pressure, immediate attention is given to stabilizing the child after a quick focused history as above [1].

The physical examination (**Box 5**) of the child can certainly help in the evaluation of the severity of the bleeding, as well as in assessment regarding possible diagnosis. The presence of anemia and orthostatic changes could point to significant blood loss. Orthostatic change is defined as an increase of 20 beats per min of heart rate, or decrease of 20 mmHg of systolic blood pressure or 10 mmHg of diastolic blood pressure on changing from a supine to upright or sitting position [6]. The presence of jaundice, ascites or hepatosplenomegaly could point towards chronic liver disease [1]. In a child with chronic diarrhea, weight loss or growth failure, the bleeding could indicate inflammatory bowel disease.

Box 2. Causes of hematochezia and melena.

- Upper gastrointestinal source: see causes of hematemesis
- Infectious colitis: *Salmonella, Shigella, Campylobacter jejuni, Escherichia coli* O157:H7, *Yersinia enterocolitica, Clostridium difficile, Entamoeba histolytica*, cytomegalovirus and other opportunistic infections
- Anal fissure, hemorrhoids
- Necrotizing enterocolitis
- Graft-versus-host disease
- NSAID-induced injury
- Meckel's diverticulum
- Inflammatory bowel diseases
- Eosinophilic colitis/eosinophilic gastroenteritis
- Vascular malformations
- Lymphoid nodular hyperplasia
- Colonic polyps
- Intussusception
- Volvulus
- Intestinal ischemia from vascular insult
- Trauma
- Solitary rectal ulcer

Management

Appropriate management should follow the quick initial assessment. In patients with impending or actual circulatory compromise, the resuscitation should be prompt. The patient should have vascular access, preferably two wide-bore intravenous lines should be inserted, diagnostic laboratory tests drawn and crystalloids should be started as initial fluids. Colloids or blood products would be necessary depending on the severity of the bleeding. Supplemental oxygen is administered through an age-appropriate device [1,7]. The initial laboratory evaluation includes complete blood count, prothrombin time, partial thromboplastin time and liver profile, which includes bilirubin, transaminases and albumin [1]. The decision to type and screen or cross-match is dependent on the extent, as well as cause of the bleeding. In acute bleeding the hemoglobin may look erroneously higher than the actual value, and hence should be interpreted with caution [7]. In patients with liver disease who presented with GI bleeding, additional studies would be necessary, such as abdominal ultrasound with Doppler flow of hepatic and portal blood flow and subsequent further investigations [1]. The placement of a NG tube can be helpful to confirm upper GI bleeding, as well as to lavage the stomach so that visualization of the upper GI tract would be superior when an endoscopy is performed [7]. This is especially useful when the child presents with significant bleeding presenting as melena, or rectal bleeding without hematemesis. Presence of fresh blood in the NG tube aspirate indicates active bleeding [1]. Suspicion of esophageal varices is not a contraindication for placing an NG tube. Several measures can be taken as supportive care, including intravenous fluids (initially normal saline or lactated Ringer's solution), blood products (packed red blood cells, fresh frozen plasma or whole blood) and vasopressors [1,7]. The hematocrit should be maintained at approximately 30% [1,2]. Correction of coagulopathy with fresh frozen plasma and platelet transfusion to keep platelets above 50,000 should be attempted [2]; however, these blood products still may not correct the coagulopathy in the presence of advanced liver disease.

Box 3. Causes of occult gastrointestinal bleeding.

- Esophagitis
- Acid peptic disease
- Gastritis
- Peptic ulcer disease
- Inflammatory bowel diseases
- Eosinophilic gastroenteritis
- Polyps
- Vascular malformations

A child with chronic liver disease is susceptible to fluid overload when receiving fluids and blood products. Recombinant factor VIIa, along with endoscopic treatment, was associated with improved hemostasis in a recent study in adults with cirrhosis [8]. Bacterial sepsis is a major complication associated with cirrhosis following an episode of variceal bleeding, and short-term use of antibiotics has shown improved survival [9].

Specific intervention, such as acid suppression with intravenous histamine 2 receptor antagonists or proton-pump inhibitors, such as omeprazole, lansoprazole, pantoprazole or esomeprazole, could be useful in upper GI bleeding, even though only limited data are available in children [6,7,10,11]. These drugs can be used orally in patients awaiting elective endoscopy, especially in suspected peptic ulcer disease or gastroesophageal reflux disease [12]. Vasopressin is an effective agent to decrease the splanchnic blood flow by splanchnic arteriolar vasoconstriction, thereby lowering portal inflow and portal pressure and subsequently decreasing variceal GI bleeding. It has significant side effects in 32–64% of patients in different clinical trials [2].

Somatostatin and its analog, octreotide, decrease the portal blood inflow and are useful in variceal and nonvariceal bleeding [1,2]. Octreotide is administered as 1 µg/kg bolus, followed by

Box 4. Causes of painless rectal bleeding.

- Colonic polyps
- Meckel's diverticulum
- Vascular malformations
- Intestinal duplication
- Coagulation disorders; platelet dysfunction

1–2 µg/kg/h as a continuous infusion in active bleeding, and has an excellent safety profile [2]. Even in patients with esophageal varices, the bleeding can certainly be occurring from other causes, such as peptic ulcer disease, Mallory–Weiss tears or gastritis, so an endoscopy would be necessary to identify the etiology and manage the bleeding [12]. Although more commonly used for variceal bleeding, octreotide may also be considered in nonvariceal bleeding, such as peptic ulcer bleeding before the endoscopy or when the endoscopy is unsuccessful or contraindicated [13].

Upper endoscopy

Upper endoscopy is indicated in hematemesis, melena, hematochezia and occult blood in stool. It is not only diagnostic, but also useful for therapeutic interventions. When the child is stable enough to be sedated, upper endoscopy can be performed. It is better to perform semi-elective endoscopy rather than an emergent endoscopy, as this allows for adequate preparation and stabilization of the patient [1,14,15]. Emergency endoscopy is performed when the bleeding continues with continued significant transfusion requirement, in which case the procedure is performed under general anesthesia with a controlled airway. The upper endoscopy can identify the site, as well as the source, of bleeding, for example, variceal bleeding, mucosal bleeding or other vascular problems, such as Dieulafoy lesion. Stigmata of recent bleed can be noted on the varix as cherry-red spots, or clots, during the endoscopy. The presence of residual blood or clots in the stomach could interfere with the visualization of the source of bleeding. Gastric lavage with placement of a NG tube improves the visualization of the bleeding at the time of endoscopy, but should be removed after evacuating the gastric contents [6,7]. Maintaining the tube for prolonged periods, especially when suction is attached, can cause mucosal injury. Intravenous erythromycin of 3 mg/kg over 30 min, 30–90 min before the endoscopy, could help to clear the gastric contents [7,16]. In stable patients presenting with recurrent hematemesis, hemoccult-positive stool or evaluation for esophageal varices, an elective endoscopy can be performed. Several therapeutic interventions that are possible during an upper endoscopy in a child with GI bleeding are discussed later.

Variceal bleeding

Both endoscopic sclerotherapy (EST) and endoscopic variceal band ligation (EBL) are available for treating esophageal varices [17]. When injected with a sclerosant, the varices become thrombosed, scarred and eventually obliterated [17]. Various sclerosants are available, such as 5% sodium morrhuate, absolute alcohol, 5% ethanolamine oleate, and sodium tetradecyl sulfate. The sclerosant is injected at the time of the endoscopy at the bleeding site, starting at the gastroesophageal junction and progressing proximally. In adults, the volume of the sclerosant injected at each site is usually 1–2 ml, and a total of 10–15 ml per session [2]. EST may cause several potential complications (**Box 6**). Esophageal ulcers are seen in up to 90% of patients the day after EST, and in approximately 70% after a week of the EST, and there is a risk of bleeding from these ulcers in up to 20% [18,19]. Limited pediatric experience has been reported with some of these modalities, as described in subsequent sections. An alternative to EST is EBL, in which an elastic band is used to strangulate the varix, thereby producing thrombosis, necrosis and sloughing of the mucosa, with subsequent healing of the ulcer resulting in the obliteration of the varix [20]. Caution must be taken in individuals who are sensitive to latex, since the bands contain natural rubber latex. Several multiband ligators are commercially available with four, six or ten bands preloaded in a plastic cylinder device [21]. The cylinder is attached to the tip of the endoscope and the varix is sucked into the cylinder. The elastic band is then released by the trigger wire when a complete 'red-out' occurs. The visibility can be affected due to the plastic cylinder at the tip of the scope. Another disadvantage is that the smallest scope that can be used to attach the banding device is 8.5 mm outer diameter, and the diameter further increases after attaching the device, which may pose a problem in infants. Esophageal ulcers develop in up to 90% of these patients in a week after the EBL. Dysphagia, chest pain, bleeding from the ulcers, esophageal strictures and bacterial peritonitis have all been reported at a decreased

Box 5. Physical examination.

General

- Level of consciousness
- Diaphoresis
- Active bleeding?

Weight

Vital signs

- Heart rate
- Respiration
- Blood pressure
- Orthostatic changes
- Capillary refill

Head, eyes, ears, nose & throat

- Jaundice
- Pallor
- Bleeding from oropharynx

Abdomen

- Tenderness
- Organomegaly (liver, spleen)
- Ascites
- Abnormal blood vessels

Skin

- Jaundice
- Bleeding
- Circulation
- Pallor
- Rash
- Vascular malformations

Rectal examination

- Perianal area: fistula, fissures, hemorrhoids
- Gross blood
- Melena

incidence with EBL as compared with EST. In a patient with adequately controlled variceal bleeding, repeat sessions of EST or EBL are needed in the subsequent weeks to further obliterate the varices [2].

In patients with recurrent or uncontrolled variceal bleeding, additional measures are needed. Balloon tamponade can be useful in achieving hemostasis in many patients, but is associated with potential complications, including airway compromise, pressure necrosis of the esophageal mucosa and a high incidence of rebleeding when the balloon is deflated [2]. Repeat endoscopic treatment may be attempted on an individual basis. Transjugular intrahepatic portosystemic shunts (TIPS) are another intervention that could be attempted to attain hemostasis in variceal bleeding. During TIPS, an artificial communication is created angiographically between hepatic and portal veins, and serves as a side-to-side portosystemic shunt, allowing portal decompression [1,22,23]. Severe congestive heart failure, severe pulmonary artery hypertension, severe hepatic failure and portal vein thrombosis, active infections, and polycystic liver disease are contraindications for TIPS placement. Several complications are also described after the TIPS procedure, including hematoma (neck and liver) pneumothorax, cardiac arrhythmia, and puncture of the gall bladder and extrahepatic portal vein. Other complications of TIPS include stent thrombosis, infection, stent migration, occlusion, hepatic encephalopathy, hemolysis and hepatic decompensation [2]. Orthotopic liver transplantation can achieve hemostasis and prevent rebleeding and liver failure; however, this is rarely available under such circumstances. If the bleeding is occurring from gastric varices, EST or EBL can be attempted to achieve hemostasis, but these have a higher incidence of rebleeding from the ulcers (more than 50% after EST). Tissue adhesives, such as acrylate glue, can be injected into the varix [2,17]. Two tissue adhesives have been studied: isobutyl-2-cyanoacrylate (bucrylate) and *N*-butyl-2-cyanoacrylate (histoacryl). Hemostasis is achieved in up to 90% of cases by using these adhesives, and variceal obliteration is achieved with two sessions in 87–100% of patients. Upon exposure to blood, the material polymerizes into a hard substance and plugs the variceal lumen, resulting in hemostasis. However, these agents are not available in the USA owing to potential side effects, such as thrombotic events and carcinogenicity in rats with cyanoacrylate [24]. Thrombin has successfully been used to inject the gastric varices [25], and TIPS have been used in the management of bleeding gastric varices [25], as have surgical shunts.

Following effective hemostasis of variceal bleeding, nonselective β-blocker therapy is the mainstay of pharmacologic therapy to prevent recurrence of variceal bleeding [26,27]. Nonselective β-blockers can also be used in the prevention of first variceal bleeding [28]. Congestive heart failure, severe asthma and heart block are contraindications to β-blocker therapy. Side effects, such as fatigue, weakness and sleep disturbances, can affect compliance with the medication. Addition of spironolactone to the β-blocker therapy has been shown to reduce the variceal pressure further than with β-blocker alone [29].

Box 6. Complications of endoscopic sclerotherapy.

- Retrosternal chest pain
- Dysphagia, both transient and long term
- Fever
- Sepsis
- Bleeding
- Bleeding from esophageal ulcers
- Mediastinitis
- Esophageal perforation
- Pericarditis
- Spontaneous bacterial peritonitis
- Esophageal strictures
- Increased risk of bleeding from portal gastropathy

Nonvariceal bleeding

There are several therapeutic interventions that can be performed during the endoscopy for nonvariceal bleeding. This is indicated in high-risk stigmata, such as actively bleeding ulcer, oozing from the base of a clot or a vessel that is visible at the base of the ulcer, since they are associated with a high risk of rebleeding [30,31]. Effective endoscopic therapy significantly reduces the incidence of rebleeding. The endoscopic techniques used to control GI bleeding are: injection, coagulation/thermal therapy, laser treatment, ligation devices and hemostatic devices. If size permits, a larger therapeutic endoscope can be used, which enables simultaneous suctioning or irrigation through one channel, with therapy being attempted through the second channel. The standard pediatric gastroduodenoscope permits the needles for the sclerotherapy, but does not allow the passage of a heater probe, multipolar probe or laser. The adult gastroduodenoscope is usually required to use the heater probe, multipolar probe or laser. The colonoscopes enable the endoscopists to perform various therapeutic interventions because of the larger size of the channel.

Injection therapy

The injection of a sclerosing agent around the bleeding vessel helps to tamponade the vessel, and then directly at the site of the vessel helps to attain hemostasis by varying the degree of tamponade, vasoconstriction and cytochemical changes, depending on the agent used [31]. Different agents are used, including epinephrine with normal saline (1:10,000 to 1:20,000), epinephrine with hypertonic (3.6%) saline, and absolute alcohol. A combination of 1:1000 epinephrine (1 ml) with normal saline (9 ml) can also be used, in which case a lower volume is used (1–2 ml) per injection site. Solutions that contain 1:10,000 epinephrine can be used at a dose of 3 ml per injection site; in either situation, 3–4 injections are used around the bleeding vessel and then at the vessel. Absolute alcohol should be used with caution, since the volume used is very small (0.1–0.2 ml per injection), and a tuberculin syringe should be used for the injection. Plasma levels of catecholamines were found to be elevated following epinephrine injection for bleeding ulcers [32]. Other adverse effects include increased bleeding, bowel ischemia, perforation and peritonitis.

Thermocoagulation

Several pieces of equipment can be used to perform thermocoagulation. A heater probe provides a fixed temperature (250°C) at the tip, and produces tissue coagulation. Pressure is applied with the probe as a tamponade before coagulation, by applying 30 J for 3–8 s in up to four applications. During the application, the patient is positioned in such a fashion to allow blood to flow away from the lesion. When used in the colon, especially the right colon, a lower setting is used owing to the thin bowel wall [31]. Perforation (1–3%), as well as bleeding (5%), can occur after heater-probe application.

Electrocoagulation

In monopolar coagulation, the current is converted to high-temperature heat at the point of tissue contact and coagulates the tissue. The pressure is applied directly over the vessel, if small, or around it, if it is a larger vessel, until the bleeding stops. Perforation is a potential problem, as well as delayed bleeding and the tissue being adherent to the tip of the electrode [31].

Bipolar or multipolar probes are more commonly used owing to the above limitations of monopolar probes [31]. The maximal temperature achieved with this method is significantly less than that of monopolar coagulation, and hence the tissue injury is less. As with the heater probe, tamponade is applied before coagulating the area. A gold probe is a bipolar electrocautery catheter with irrigation capability, and also has a Hemoglide™ coating to allow easy passage through the endoscope [103]. Universal-length disposable bipolar hemostasis probes that can be used via any scopes are also available. Short (2 s long) multiple pulses are used. Heater probes, as well as multipolar probes, can achieve hemostasis up to 90% of cases. An

argon plasma coagulator is a noncontact method of delivering high-frequency monopolar current by delivery of ionized, electrically conductive argon gas or argon plasma through the coagulation probe with the electrode at the tip [31,33]. Ionization of the gas results in conduction of the spark to the nearest point, and this results in coagulation. Multiple-site treatment is possible. The argon plasma should be aspirated frequently to avoid overdistension of the bowel. argon plasma coagulator can be used to treat vascular ectasias, angiectasias, radiation-induced proctopathy, bleeding ulcers and residual adenomatous tissue. One pediatric series reported minor complications in 17% of cases, success with hemostasis in 66% with one session and recurrence of bleeding in 25% [34]. Several complications, such as pneumatosis intestinalis, ulcerations at the site, pneumoperitoneum, bleeding, stricture, perforation and death, are reported.

Hot biopsy

Hot biopsy forceps have the advantage of obtaining the tissue for examination and simultaneously attaining hemostasis by electrocoagulating the base [31]. Small lesions, such as polyps up to 5 mm in size, can be removed by hot biopsy and small vascular ectasias can be treated. Perforations, precipitation of bleeding and delayed bleeding are known complications.

Laser photocoagulation

Laser has been used in hemostasis in GI bleeding [31]. However, there are potential complications, including: precipitation of bleeding, perforation, laser burns, and injury to the user and assistants, in addition to difficulties with cost and decreased portability. The neodymium:yttrium–aluminum garnet (ND:Yag) laser is predominantly used in gastroenterology.

Hemostatic clips

Stainless steel two- or three-pronged clips are available as ready-to-use packages [35]. Newer versions can rotate inside the endoscope to achieve optimal positioning, and can open and close multiple times before being applied. Unlike the injection therapy, clips are applied directly at the bleeding vessel first. Hemostasis can be achieved in 84–100% with clips, and can be followed by other modalities, such as injection therapy [36]. Most clips will pass within 2–4 weeks. Perforation has been reported.

Loops

For lesions such as large polyps, before snare polypectomy, the loop can be applied at the base to prevent bleeding. Preloaded detachable nylon loops are applied through the endoscope and the base ligated: When they are correctly applied they show color change. Care must be taken to avoid the entanglement of the loop in the snare [31]. Combination therapy with more than one intervention produces more effective hemostasis, such as application of hemostatic clips followed by injection therapy, or injection therapy with thermocoagulation or heater probes, and decreases the need for surgery [36,37]. Such emergencies are not common in pediatrics, so it is important to have a network with adult gastroenterology colleagues who can help by providing the necessary equipment and expertise to deliver many of these therapeutic interventions.

Colonoscopy

Colonoscopy is performed in children who present with hematochezia and occult blood-positive stool when the upper endoscopy fails to reveal the cause. Although usually performed in a semi-elective or elective manner, urgent colonoscopy may occasionally be needed. In the absence of proper bowel preparation, it is a difficult but feasible endeavor after rapid intestinal lavage with polyethylene glycol solutions [38]. A NG tube may be necessary in most children, owing to the large volume needed to adequately prepare the colon. Inflammatory bowel disease can be diagnosed by biopsies from the GI tract during upper endoscopy, as well as colonoscopy. Polyps can be removed by electrocautery using hot biopsy forceps or bipolar snares, depending on the size. The endoscopic interventions discussed earlier can also be performed, as appropriate, during colonoscopy to achieve hemostasis.

Other investigations, such as CT angiography with embolization of the bleeding vessel, may be necessary in lesions that are not amenable through the endoscopes [39]. A Meckel's scan can identify a Meckel's diverticulum, and thus enable a surgical intervention to proceed [40]. The (99m)Tc red blood cell scan is useful in identifying the location of GI bleeding not visualized by upper or lower endoscopy. The location of a lesion as indicated by a positive scan within 2 h is helpful for guiding surgical intervention and angiography, although a definitive diagnosis usually requires additional methods, particularly laparotomy [41,42].

Double-balloon endoscopy of the small bowel has opened new dimensions in the management that were of obscure GI bleeding by identifying lesions previously not accessible. This has been successfully used in children [43]. Wireless capsule endoscopy is being increasingly used to identify the source of obscure GI bleeding; this can guide in planning the intervention, depending on the pathology and its location [44,45].

Surgical colleagues should be consulted in any child if the bleeding is not amenable to endoscopic intervention or to medical therapy, such as in nonresponding fulminant colitis, or if the bleeding is from a surgically curable condition, such as Meckel's diverticulum. Elective surgical consultation is necessary in patients with familial adenomatous polyposis. A team of emergency room physicians, pediatric gastroenterologists, surgeons, interventional radiologists and intensivists is necessary for delivering optimal care of a patient with significant GI bleeding.

Future perspective

Since GI pathology is different in children than in adults, such life-threatening situations arise less frequently in pediatrics. Specialized pediatric endoscopy centers can provide training in therapeutic intervention techniques, and even then, use of a training simulator would be essential in achieving such skills. This is a situation similar to liver transplant centers. However, close cooperation with adult gastroenterologists, surgeons and intensivists can help with management locally, rather than requiring transfer to specialized centers. Multicenter studies are needed to provide data on the etiology, intervention and outcomes of such patients. With the advent of liver transplantation, the incidence of variceal bleeding from chronic liver disease is decreasing, so competence at such procedures for trainees is important. Emergence and widespread availability of new methods, such as wireless capsule endoscopy and double-balloon endoscopy, will help in the visualization of the site of the bleeding and in optimizing the outcome.

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Executive summary

- Although gastrointestinal (GI) bleeding in children can present a challenge to the caregiver, as well as to the physician, it can be effectively managed.
- A focused initial review of the patient and stabilization, followed by in-depth evaluation and management, is necessary for appropriate management of the patient.
- Variceal bleeding can be best managed by supportive care and pharmacological and therapeutic intervention, such as variceal banding, even though such procedures can be challenging in younger patients owing to their small size.
- Bleeding nonvariceal lesions may be best managed by combination therapy, such as injection therapy with a heater probe, or clip devices with injection therapy.
- Double-balloon endoscopy can be a useful, but not easily available, test.
- Wireless capsule endoscopy and enteroscopy can be a useful alternative to aid in the evaluation of GI bleeding not identified by upper and lower endoscopy.
- The use of colonoscopy with or without the use of some of the therapeutic modalities can aid in the management of lower GI bleeding.

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