Chapter 11
Pediatric population

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Intro

The pediatric mantra "children are not just small adults" certainly holds true for the evaluation and management of occult gastrointestinal bleeding. Unlike the adult population in which fecal immunochemical testing or guaiac based hemoccult testing are commonly performed to detect occult bleeding as part of routine colorectal cancer surveillance algorithms, evaluation for occult bleeding in children is most often triggered by findings of unexplained and/or refractory anemia. Although the differential diagnosis of occult gastrointestinal blood loss in children has similarities to adult causes, there are several pediatric specific processes that vary based on the age of the child. While occult bleeding in adults raises concern for potential gastrointestinal malignancies, these are extraordinarily rare in pediatrics. In contrast, problems such as allergic colitis (cow milk protein allergy), anatomic abnormalities (juvenile polyps, Meckel's diverticulum, vascular malformations, anastomotic ulcers and intestinal duplications), and inflammatory etiologies (Crohn's disease) are more prevalent in infant, school aged, and adolescent populations respectively. Furthermore, there are particular pediatric specific implications in the diagnostic and therapeutic approach, particularly in infant and preschool aged children. These include limitations interpreting fecal occult blood testing as well as challenges with endoscopic evaluation. Patient age and size present potential barriers when obtaining small bowel evaluation with capsule endoscopy or enteroscopy. Addressing the causes of occult gastrointestinal bleeding with therapeutic endoscopy can also be more challenging since there are fewer endoscopic tools available because of the smaller working channel on 5.2 mm endoscopes.

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Epidemiology/Etiology

It is difficult to ascertain the epidemiology of occult gastrointestinal bleeding in pediatrics given its occult nature, underrecognition, and diagnostic limitations. In general, the epidemiology of all pediatric gastrointestinal bleeding, both occult and overt bleeding, is poorly elucidated in the current literature [1, 2]. While overt gastrointestinal bleeds have more obvious clinical signs of hematemesis, melena, etc. the suspicion for occult bleeding relies on more subtle findings of pallor and iron deficiency anemia in combination with fecal occult blood testing.

The potential etiologies which formulate the differential diagnosis of occult bleeding in pediatrics are unique to that of their adult counterparts. In approaching pediatric occult gastrointestinal bleeding, clinicians must take into account the patient's age as well as the presenting symptoms and physical exam. Dividing populations up into infant/preschool, school aged, and adolescent can be helpful in approaching potential causes of gastrointestinal bleeding in children (Table 11.1). Overall, children show a greater likelihood of having anatomic abnormalities such

Table 11.1 Etiology of occult gastrointestinal bleeding by age

	Infant/preschool	School aged	Adolescent
Inflammatory	Allergic Cow milk protein allergy (allergic colitis) Eosinophilic gastrointestinal disease Celiac sprue Gastritis/esophagitis	Celiac sprue Very early onset IBD Gastritis/esophagitis Eosinophilic gastrointestinal disease Lymphonodular hyperplasia	Inflammatory bowel disease Celiac sprue Gastritis/esophagitis Eosinophilic gastrointestinal disease Lymphonodular hyperplasia
Anatomic	Juvenile polyps Meckel's diverticulum Gastrointestinal duplications Anastomotic ulcers	Juvenile polyps Meckel's diverticulum Gastrointestinal duplications Anastomotic ulcers	Meckel's diverticulum Juvenile polyps Gastrointestinal duplications Anastomotic ulcers
Vascular	Telangiectasia Hemangiomas Vasculitis (Henoch Schönlein Purpura)	Telangiectasia Hemangiomas Angiodysplasia Vasculitis (Henoch Schönlein Purpura)	Telangiectasia Hemangiomas Angiodysplasia Vasculitis (Henoch Schönlein Purpura)
Hepatobiliary	N/A	Esophageal/rectal varices Portal vein thrombosis Cirrhosis	Esophageal/rectal varices Portal vein thrombosis Cirrhosis
Infectious	Hookworm Strongyloides/Ascaris	Hookworm Strongyloides/Ascaris	Hookworm Strongyloides/Ascaris
Malignancy	N/A	Gastrointestinal stromal tumors (GIST)	Gastrointestinal stromal tumors (GIST)
Miscellaneous	Coagulation disorders Non-accidental trauma	Coagulation disorders Non-accidental trauma	Coagulation disorders Non-accidental trauma

as small intestinal polyps, Meckel's diverticulum, intestinal duplications, vascular malformations, as well as inflammatory etiology such as Crohn's disease compared to their adult counterparts.

Inflammatory

Allergic

Cow milk protein allergy (CMPA), also referred to as food protein induced colitis/enterocolitis, is a non-IgE mediated food protein induced allergic inflammatory disorder that has a diverse spectrum of clinical manifestations. These range from non-specific symptoms such as abdominal pain, fussiness, poor weight gain, regurgitation, emesis, and loose stools to more striking symptoms such as growth failure, hematochezia, acidosis, and enterocolitis syndrome [3, 4]. Gastrointestinal blood loss is more often occult, though can progress to more fulminant proctocolitis with overtly bloody stools. Cow milk protein allergy presents in infants with the peak onset at around 4–6 months of age. Its overall incidence is estimated to be quite high at nearly 2–3% of infants out of a general population cohort [3], and is even higher in some select populations including premature infants. The natural course of this disorder is gradual resolution over the first 2 years of life and in normally growing children with no other symptoms besides occult blood loss, families can continue an unrestricted diet with close outpatient monitoring. While histopathology reveals a predominately eosinophilic infiltrate [4, 5], the diagnosis of CMPA is typically a clinical diagnosis and endoscopy/colonoscopy is not routinely recommended. Rather CMPA can be presumed based off of compatible clinical history, exclusion of other potential etiologies, and symptomatic response when breastfeeding mothers restrict their diet or infants are transitioned to a partially hydrolyzed or elemental formula. While the majority of infants will have clinical response and resolution of bleeding with transition to a partially hydrolyzed formula, a small percentage will require an elemental formula [6]. CMPA is the most common etiology for occult gastrointestinal blood loss in the first year of life. Attempts to comport the diagnosis with positive fecal occult blood test are limited by its poor specificity in this age range and thus the diagnosis of CMPA largely remains a clinical diagnosis based on symptom constellation and clinical response to dietary exclusion [7].

Celiac

Celiac disease is an immune-mediated enteropathy driven by gluten sensitivity and it is highly prevalent with estimated rates of pediatric Celiac disease ranging from 1:300 to as many as 1:80 children. The classic presentation of abdominal distention,

diarrhea, and weight loss/growth failure is more common in childhood celiac disease than in adults [8]. However, with increased availability and widespread use of serologic testing, there has been a shift in how children with celiac disease present with one study describing the classic symptomatology decreasing from 67% to 19% [9]. They attributed this to increased detection of atypical cases in older children and adolescents which led to a dramatic corresponding shift in the average age of diagnosis from approximately 2 years of age to 9 years of age during that same time span [9, 10]. While the presentation of refractory iron deficiency anemia has long been well described in adult celiac patients, it was only more recently confirmed as a common initial manifestation in children. One pediatric cohort study demonstrated that upwards of 25% with refractory iron deficiency anemia had positive celiac serologies and another noted that more than 25% of children with untreated celiac disease had a positive fecal occult blood test [11, 12]. This yielded recommendations for early celiac serologic screening in the setting of iron deficiency anemia and concern for occult bleeding in order to make more timely diagnosis, minimize celiac associated complications, and avoid repeated courses of iron supplementation [8].

Inflammatory Bowel Disease

With an incidence of 10 per 100,000 children, there are approximately 70,000 children with inflammatory bowel disease (IBD) in the United States. Although children frequently present with abdominal pain, diarrhea, and weight loss, a small percentage of children have symptoms associated with anemia alone. Unexplained iron deficiency anemia with gastrointestinal bleeding, particularly in school aged and adolescent patients, must raise concern for IBD. While in younger children with occult GI bleeding the possibility of IBD must be entertained, very early onset inflammatory bowel disease defined as onset of symptoms prior to 6 years of age is quite rare. Chronic occult blood loss and iron deficiency are a common presentation for inflammatory bowel disease in the pediatric population, with 67–76% of children with IBD having anemia at the time of diagnosis [13]. Interestingly, 70% of school age children with IBD present with anemia compared to 42% in adolescents and 40% in adults [14]. Diagnosis of children with suspected inflammatory bowel disease frequently relies on laboratory testing, though fecal occult blood testing has been suggested as a screening tool. In one study of 335 children undergoing testing for IBD, combining screening laboratory studies with fecal occult blood testing and perianal examination increased the sensitivity of diagnosing IBD from 80.5% to 97.6% [15].

Helicobacter Pylori

Helicobacter pylori infection in children is a frequent cause of upper abdominal pain, nausea and dyspepsia. Although noninvasive screening for H pylori exist, national guidelines still recommend endoscopic evaluation to evaluate for infection [16]. Indeed nodular antral gastritis is a nearly pathognomonic finding for childhood H pylori infection and is seen more commonly in children than in their adult counterparts [17]. Lymphoid follicle hypertrophy and thickening of the gastric mucosa folds were also seen more commonly in the pediatric population, while gastric mucosal atrophy, intestinal metaplasia and dysplasia occurred less frequently in children. Because H pylori has been associated with duodenal ulcers and chronic gastritis, children can have both positive fecal occult blood tests and iron deficiency anemia with an active H pylori infection. Several meta-analyses have confirmed that the association between unexplained iron deficiency anemia and H pylori infection is also seen in pediatrics [18, 19]. Diagnostic testing for H. pylori infection should be considered in children with refractory iron-deficiency anemia. Indeed, one small study evaluating adolescents with unexplained iron deficiency anemia found that the most common endoscopic finding was antral gastritis. With almost 40% of their cohort population having histopathologic findings consistent with H pylori infection, this prompted guidelines to recommend targeted biopsies for H pylori on upper endoscopy for the indication of iron deficiency anemia [16, 18, 19].

Anatomic

Juvenile polyps are the most common cause for painless lower gastrointestinal bleeding in children [20, 21]. Frequently, bleeding associated with colonic polyps is overt bright red blood per rectum, but presentation is variable based on polyp location and can be more insidious in nature. Juvenile polyps are hamartomatous growths that are commonly seen in children with peak age on incidence from 2 to 4 years of age. Large retrospective cohort indicates that the incidence of colorectal polyp across all pediatric colonoscopies is approximately 6% irrespective of indication, but increases to 12% for indication of lower gastrointestinal bleeding [21]. Younger age, male sex, and non-white race were all significantly associated with polyp detection. However, it appears that the likelihood of polyp detection may be significantly higher in certain populations as smaller cohort studies have found incidence rates that range as high as 42–57% based on population characteristics [22, 23]. In children and adolescents, 85–90% of polyps are juvenile (hamartomas) polyps with the remainder made up of hyperplastic/inflammatory polyps and adenomas. The vast majority of patients (80–95%) will have a single isolated polyp detected with the bulk of these located in the left colon [22]. One study characterizing distribution of juvenile polyps noted that 68% were isolated to rectum, 20%

to the rectosigmoid, and 12% in the descending colon [21, 23]. While single isolated polyps are predominant, the presence of multiple polyps, particularly in the setting of positive family history or polyp location outside the colon should raise concern for genetic polyposis syndromes prompting consideration for further diagnostic evaluation. Small bowel polyps in particular can represent an obscure cause for occult bleeding that may not be readily identifiable with standard esophagogastroduodenoscopy and ileocolonoscopy.

A number of other anatomic variants can manifest with gastrointestinal bleeding early in childhood. These includes Meckel's diverticulum which is a small outpouching that represents the most prevalent congenital abnormality of the gastrointestinal tract. It is a remnant of the omphalomesenteric duct and has associated ectopic gastric or pancreatic tissue in estimated 44% and 37% of cases respectively [24]. While most characteristically it presents with overt episodes of painless gastrointestinal bleeding it has been described in cases of insidious chronic bleeding and may also represents an incidental finding in completely asymptomatic individuals. It is classically known for its "rule of 2's" in which estimated fraction of 2% of the population has this small diverticulum with typical length of approximately 2 inches and location roughly 2 feet from the ileocecal valve. The peak age of incidence is prior to 2 years of age and frequently the diverticulum expresses ectopic gastric tissue which predisposes to bleeding. While Meckel's is most commonly described it is possible to get duplication cysts in a number of locations throughout the gastrointestinal tract and if gastric ectopic tissue is present so too is the potential risk for bleeding. Technetium-99 m pertechnetate imaging offered high diagnostic yield in detecting Meckel's or other diverticulum which express ectopic gastric mucosa [24, 25].

Chronic occult bleeding and anemia are well described long term complications associated with ulcer formation at intestinal anastomoses. Ileocolonic anastomotic sites in infants with history of necrotizing enterocolitis are commonly described to have delayed complications such as ulcer formation (Fig. 11.1a). One

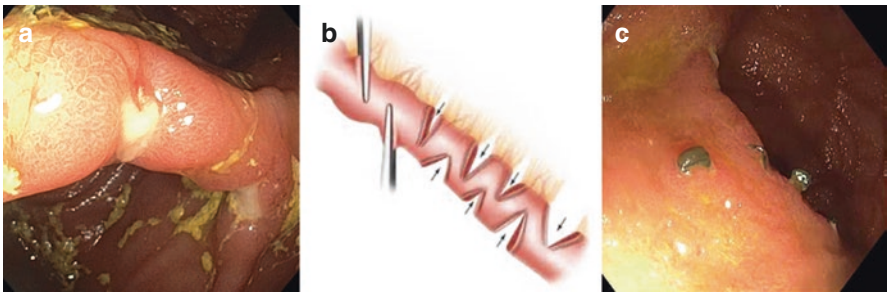

Fig. 11.1 Anastomotic ulceration. (**a**) Ulceration at ileocolonic anastomosis. (**b**) Serial transverse enteroplasty [26]. (**c**) Staple line erythema as a complication of serial transverse enteroplasty (STEP) bowel lengthening procedure

study described symptomatic ulceration at previous ileocolonic anastomosis in six children who had underwent ileocecal resection for necrotizing enterocolitis with mean onset of symptoms over 5 years after initial successful surgical management. The etiology for these inflammatory ulcerations is unclear but anecdotally they are refractory to treatment with anti-inflammatory medications and have high recurrence rate following surgical revision [27]. Ileocolonic anastomoses seem particularly vulnerable to anastomotic ulcer bleeding and multiple studies demonstrate the timing can be markedly delayed with one study showing the interval between surgery and detection of anastomotic ulcer ranged from 15 months to over 2 decades. In this study where a small cohort of patients with ileocolonic anastomotic ulcer bleeds underwent surgical revision, the majority failed to demonstrate clinical improvement with ulcer recurrence at the new anastomotic site [28]. Additionally, staple line associated ulcerations in patients with intestinal failure who have undergone serial transverse enteroplasty procedure (STEP) for bowel lengthening is a well described phenomenon that leads to chronic refractory occult gastrointestinal bleeding (Fig. 11.1b, c) [29].

Vascular

Multisystem vascular disorders and vascular anomalies including angiodysplasia, telangiectasia, hemangiomas, and more rare vasculocutaneous syndromes such as blue rubber bleb nevus syndrome can lead to chronic occult gastrointestinal blood loss (Table 11.2) [2]. Additionally, genetic polyposis syndromes are often associated with occult bleeding. These commonly present in childhood and careful physical exam and history can be helpful in raising suspicion for such vascular lesions and polyposis syndromes. Skin findings such as telangiectasias, blue nodules, hemangiomas, or pigmented macules (lentigines) raise suspicion for multisystem vascular disorders such as hereditary hemorrhagic telangiectasia, blue rubber bleb nevus syndrome as well as polyposis disorders, such as Peutz-Jeghers syndrome and juvenile polyposis syndrome (Fig. 11.2) [2, 30].

Table 11.2 History and cutaneous findings associated with multisystem vascular and polypsosis syndromes

Cutaneous manifestation, historical clues	Diagnosis/vascular lesion
Oral lentigines, pigmented macules	Peutz-jeghers (Hamartomatous polyps)
Epistaxis, cutaneous telangiectasia's, and positive family history	Osler-Weber-Rendu or hereditary hemorrhagic telangiectasia
Cutaneous hemangiomas	Infantile visceral hemangiomas
Multifocal nodular blue venous malformations	Blue rubber bleb nevus syndrome
Purpuric rash, abdominal pain, hematuria	Henoch Schonlein Purpura (IgA mediated vasculitis, intestinal purpura)
	Juvenile polyposis syndrome

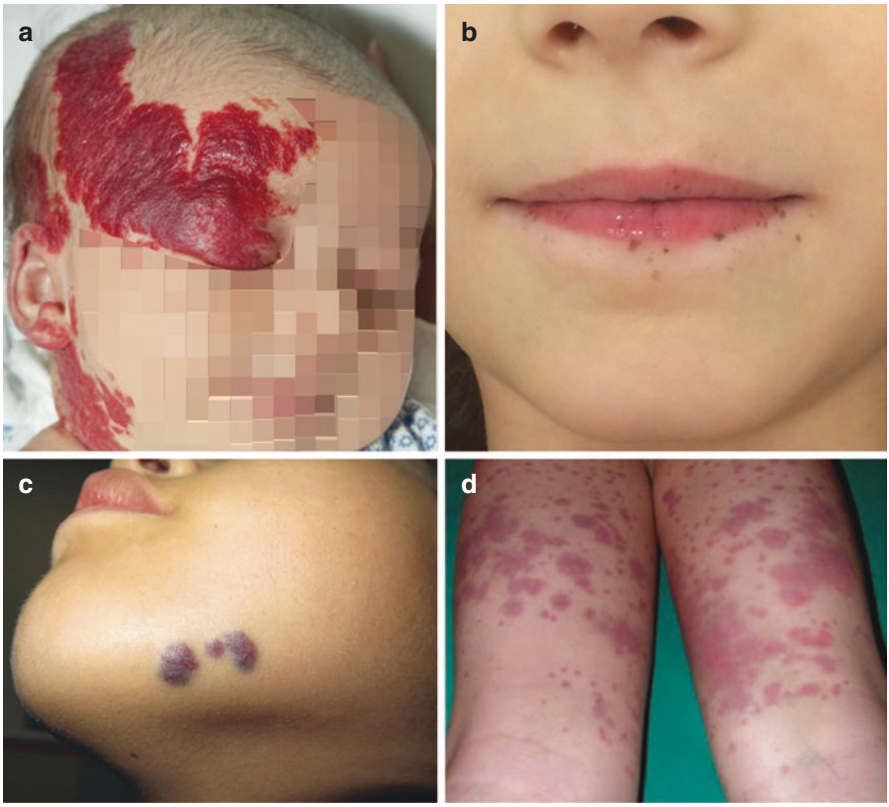

Fig. 11.2 (**a**) Segmental hemangioma seen in PHACES Syndrome [31]. (**b**) Oral lentigines associated with Peutz-Jegher Syndrome. (**c**) Blue vascular lesions in Blue Rubber Bleb Nevus Syndrome [32]. (**d**) Palpable purpura of Henoch-Schönlein Purpura [33]

Hepatobiliary

Esophageal varices and portal hypertensive gastropathy related to chronic liver disease can present with occult gastrointestinal bleeding (Fig. 11.3). Overall, chronic liver disease presenting with portal hypertensive sequelae is relatively uncommon in the pediatric population. However, variceal bleeding from portal hypertension caused by cirrhosis from chronic liver disease or portal vein thrombosis may occur. Prematurity and history of umbilical vein catheterization as well as hypercoagulable disorders are notable risk factors for portal vein thrombosis. Smoldering chronic hepatitis from Wilson disease, alpha-1 antitrypsin, or autoimmune hepatitis leading to cirrhosis infrequently presents as unexplained anemia from varices or portal gastropathy.

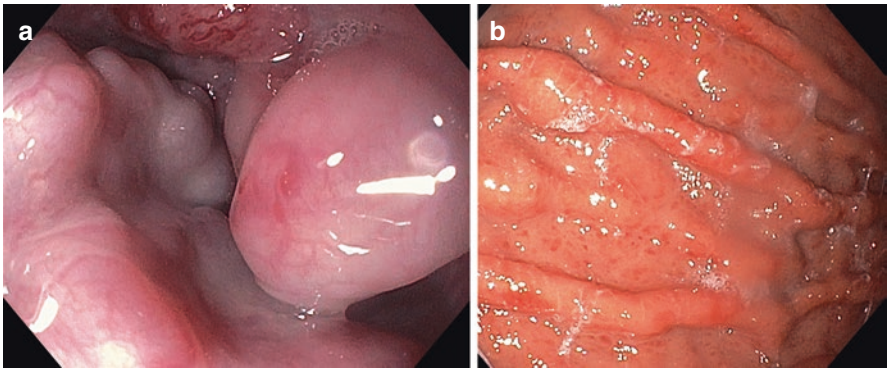

Fig. 11.3 Sequelae of portal hypertension in children. (**a**) Esophageal varices from portal vein thrombosis (**b**) portal gastropathy from autoimmune hepatitis

Infectious

Although chronic helminthic infections in the United States and other developed nations are relatively uncommon given sanitation efforts and safe water supply, parasitic infection still must be considered in the evaluation of occult gastrointestinal bleeding. This particularly should be a concern in the setting of growth failure. Careful history to elucidate risk factors such as immigrant status and history of recent international travel should direct attention towards ova and parasite testing as part of the evaluation of chronic bleeding. Hookworm, Strongyloides, and Ascaris are the most common helminthic infections to manifest with occult bleeding.

Malignancy

In contrast to the adults where occult bleeding may portent colorectal carcinomas, gastrointestinal malignancies are exceedingly rare in children. Secondary malignancies with intestinal metastasis are more common than primary tumors. Of those primary gastrointestinal tumors, gastrointestinal stromal tumors are the most common though still quite rare with an estimated incidence of 0.02 cases per million children [34]. Juvenile polyposis syndromes place individuals at increased risk for development of intestinal malignancy, but most of these carcinomas manifest beyond the second decade of life.

Diagnostic Considerations

In adult populations screening for fecal occult blood with stool guaiac based and immunohistochemical screening methods is commonplace to evaluate for occult gastrointestinal blood loss and plays a huge role in surveillance for early detection of colonic malignancies. However, widespread use in pediatrics is more limited particularly in infants and younger children. Multiple studies have demonstrated that stool guaiac has poor specificity in the infant population [7, 35, 36]. One study looked at fecal occult blood tests in all hospitalized infants, irrespective of the etiology for their admission, and found that approximately 22% of infants had at least one positive hemoccult result during their inpatient stay [35]. A more recent study trying to determine the role of fecal occult blood testing in screening for cow milk protein allergy found that their asymptomatic control populations of healthy infants at standard well checks had positive stool guaiac rates of 34% despite the absence of any gastrointestinal symptoms [7]. Given its marked poor specificity, fecal occult blood testing in the infant population is not recommended and must be interpreted with caution as it may lead to excessive diagnostic workup, treatment, and unnecessary formula changes. The exact mechanism to explain this high positive stool guaiac test rate is poorly elucidated at this point, but is speculated to represent a degree of immaturity of barrier function and immunity in the gut.

Endoscopy

Chronic occult gastrointestinal bleeding may occur anywhere in the gastrointestinal tract from the oral cavity to the anus. In most cases, the site can be identified by upper endoscopy and ileocolonoscopy. Esophagogastroduodenoscopy and colonoscopy are the first line diagnostic tools for detection of occult gastrointestinal bleeding. However, while the yield of endoscopy for detection of overt gastrointestinal bleeding is well defined, the yield of esophagogastroduodenoscopy and colonoscopy for evaluation of occult gastrointestinal bleeding and iron deficiency anemia is less clearly delineated in the pediatric literature.

Insidious blood loss from the gastrointestinal tract has been identified as one of the most frequent causes of iron deficiency anemia in older children and adolescents. Two retrospective studies examining the yield of esophagogastroduodenoscopy for evaluation of unexplained chronic iron deficiency anemia and gastrointestinal bleeding suggested that the diagnostic yield was 53% and 57% respectively [18, 37]. In the cohort of patients with unexplained chronic iron deficiency anemia the most common endoscopic abnormalities described were antral gastritis followed by duodenal ulcers [18]. However, the remaining cases of obscure gastrointestinal bleeding in which occult bleeding is not localized with endoscopy or small bowel radiological imaging is referred to as obscure-occult bleeding and these patients benefit from further small bowel evaluation for the source of bleeding [1]. A separate study evaluating diagnostic yield of colonoscopy for various

indications found a yield of approximately 66% which was second only to the etiology of overt lower gastrointestinal bleeding [38].

Once endoscopic abnormalities are detected the ability to provide therapeutic intervention can have pediatric size specific obstacles. Particularly in neonates and young infants, smaller caliber endoscopes are necessary which often have a narrow diameter and smaller working channel which can restrict options for therapeutic intervention of bleeding. Commercially available gastroscopes for infants commonly have an outer diameter of approximately 5.5 mm and a working channel diameter of approximately 2.0 mm. When no source of bleeding is found on EGD and colonoscopy, bleeding from the jejunum or proximal ileum is usually the culprit. Evaluation of the small bowel is technically challenging at baseline in all populations, but certainly pediatric size can play a role in complicating evaluation of small bowel disease.

Wireless Capsule Endoscopy

Wireless capsule endoscopy (WCE) is a minimally invasive technique for the evaluation of small bowel pathology and obscure gastrointestinal bleeding (Fig. 11.4). It was first employed in the pediatric population in 2004 for use in adolescent patients

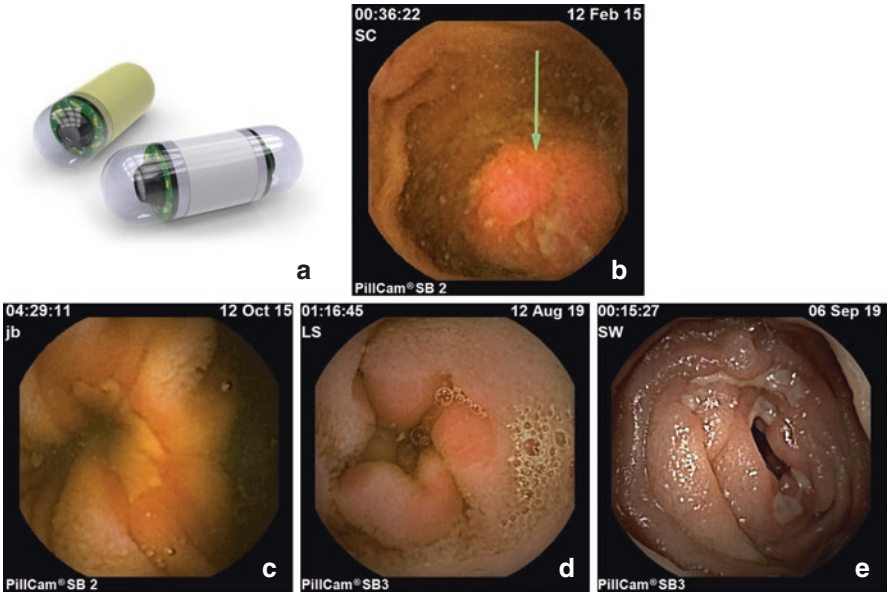

Fig. 11.4 (**a**) Wireless capsule endoscopy [39]. (**b**) Small bowel polyp (**c**) Small bowel aphthous ulcer (**d**) Small bowel ulceration from eosinophilic gastroenteritis (**e**) Small bowel Crohn's disease

10–18 years of age and was later expanded to use in children greater than 2 years of age in 2009. Over the past decade it has steadily gained traction as the primary modality for assessing small bowel disease involvement. While an early case series was concerning for a relatively high adverse event rate from capsule retention and capsule failure requiring endoscopic or surgical retrieval, these have not been realized in larger scale studies that demonstrate an excellent safety profile [40–42]. Even in populations with established Crohn's disease where risk of stricture is the greatest, wireless capsule endoscopy has been found to have an excellent safety profile with minimal risk of retention [41, 42]. To assuage concerns regarding potential capsule retention, passage of a dissolvable patency capsule is typically recommended to exclude an unrecognized stricture prior to video capsule swallowing or deployment.

The diagnostic yield for WCE in pediatrics is estimated to be as high as 61% across all indications. However, its yield appears to be greatest in evaluation of polyposis syndromes and established Crohn's disease with rates of detection of positive findings in 75% and 65% for these populations respectively. While in comparison, yield in detection of a small bowel source of obscure gastrointestinal bleeding and iron deficiency anemia ranges from 27% to 42% [41, 43, 44]. While WCE has gained traction in the assessment of small bowel disease, certain limitations and pediatric implications still apply. Tolerability of capsule swallowing remains a pediatric specific barrier as the typical video capsule measures 26 × 11 mm and thus remains an obstacle for ingestion in young children. One study evaluating tolerability of video capsule endoscopy in school aged children identified age, height, and prior experience with capsule swallowing as the best predictors and determinants of swallowability. If children are unable to swallow the pill, endoscopic deployment is typically completed at the time of EGD. However, placement at the completion of upper endoscopic evaluation with biopsy can complicate interpretation given the creation of biopsy related bleeding as possible artifact in the small bowel that must be distinguished and differentiated by the interpreter from true small bowel pathology. WCE is most commonly employed for the evaluation of chronic gastrointestinal bleeding in the setting of Crohn's disease with known normal upper and lower endoscopy findings. Further limitations of WCE are similar to that in adults in that it does not allow for direct tissue sampling, leads to imprecise localization of bleeding, and inability to therapeutically intervene. WCE is a novel, noninvasive, and useful tool for the investigation of the small intestine in children. It is superior and more sensitive than other conventional endoscopic and radiologic investigations in the assessment of the small bowel and should be routinely employed as a diagnostic tool in the work-up of obscure gastrointestinal bleeding.

Small Bowel Enteroscopy

Balloon assisted enteroscopy to assess for a small bowel source of bleeding has been used sparingly in the pediatric population largely due to limited experience and lack of expertise in performing enteroscopy in small children. However, case

reports have described the success of single balloon assisted anterograde enteroscopy and retrograde enteroscopy in patients as young as 3.7 years and 1.6 years respectively and with lowest body size down to 12.9 and 10.8 kg respectively [45, 46]. While anterograde and retrograde techniques are both employed, anal route retrograde enteroscopy has been associated with shorter procedure duration for achieving diagnosis. The overall diagnostic yield for small bowel lesions using double balloon enteroscopy ranges from 48% to 70% depending on patient population, indication, and inter-center variation [46–49]. Enteroscopy findings in the setting of occult bleeding include most commonly polyps, mucosal ulcers and erosions, and more rarely angiomas, angiodysplasia, and other vascular anomalies. Head to head studies have demonstrated similar diagnostic yield between WCE evaluation and double balloon enteroscopy but note that enteroscopy is advantageous in that it facilitates the possibility of endotherapeutic intervention to address abnormal mucosal findings. Studies have shown up to 46.5% success rate in completion of therapeutic intervention with small bowel enteroscopy. Many experts purport the usage of MR-enterography and capsule endoscopy as complementary in tools in the diagnostic work-up to better identify candidates appropriate for enteroscopy. One study evaluating an algorithmic approach of WCE evaluation prior to enteroscopy found that capsule endoscopy enhances the diagnostic and therapeutic yield of enteroscopy to 95% and 82% respectively. Although the procedure is technically challenging, few major complications have been reported and are primarily associated with therapeutic interventions [48]. Ultimately, few centers have sufficient patient volume and technical expertise to perform routine enteroscopy in young children, and thus it has not become a mainstay in the evaluation of small bowel pathology.

Radiology Evaluation

Diagnosis of lower gastrointestinal bleeding (LGIB) represents a significant diagnostic and therapeutic challenge and the utilization of radiologic cross sectional imaging is often helpful. While CT enterography (CTE) has been utilized in adults with occult LGIB, its use in children has been primarily limited to evaluation of extent of disease for patients with inflammatory bowel disease. Although, one study suggests CTE may have value in localizing the source of LGIB prior to surgical or endoscopic intervention [50]. However, the benefit of earlier lesion identification prior to endoscopy evaluation must be weighed against the radiation exposure and patient discomfort due to bowel distention associated with enterography. In addition to cross sectional imaging, nuclear medicine technetium-labeled tagged red blood cell scans have also been utilized to locate occult GI bleeding. Although typically thoughts of more often in individuals with larger lower GI bleeds since there is a threshold of active bleeding necessary to detect the bleeding, reports that as little at 0.1 ml/min is needed to detect a bleed [51]. Although little data is available on tagged red blood cell scans in children, a 2008 study of 22 patients with GI bleeding demonstrated a diagnostic yield of almost 40% with this study [52].

Conclusion

Occult gastrointestinal bleeding is a relatively uncommon problem in the pediatric population but fecal occult blood testing should be considered in children with unexplained anemia. There are more differences than similarities in the causes of occult gastrointestinal bleeding in children compared to adults. Careful consideration of the child's age, history and physical exam is important when deciding on the most appropriate diagnostic test for occult gastrointestinal bleeding. Evaluation with endoscopy, wireless capsule endoscopy and radiographic imaging is similar to that of adults but can be more challenging primarily due to size limitations in young children.

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