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#### Contributor Disclosures

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**INTRODUCTION** — The passage of gastric contents into the esophagus (gastroesophageal reflux [GER]) is a normal physiologic process that occurs in healthy infants, children, and adults. Most episodes are brief and do not cause symptoms, esophageal injury, or other complications. In contrast, gastroesophageal reflux disease (GERD) occurs when the reflux episodes are associated with symptoms or complications. The type of symptoms and complications of GERD in children vary with the child's age.

Several treatment options are available for controlling symptoms and preventing complications in children with GERD. The choice among them depends upon the patient's age, the type and severity of symptoms, and response to treatment.

This topic review focuses on the management of GERD in children and adolescents. Other topic reviews relevant to GER and GERD in the pediatric age group are:

- [Clinical manifestations and diagnosis of gastroesophageal reflux disease in children and adolescents](#)
- [Gastroesophageal reflux in infants](#)
- [Gastroesophageal reflux in premature infants](#)

These discussions are generally consistent with an official consensus statement and systematic review issued by the North American Society of Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN) and European Society of Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) [1], and the American Academy of Pediatrics (AAP) [2]. The full text of the [NASPGHAN guideline](#) is available at the society website.

**LIFESTYLE CHANGES** — We suggest lifestyle changes as an initial approach to treatment for children and adolescents with mild or infrequent symptoms of gastroesophageal reflux (GER), such as occasional heartburn or painless regurgitation. Lifestyle changes also may be helpful as an adjunct to pharmacologic treatment in patients with moderate or severe symptoms suggestive of gastroesophageal reflux disease (GERD).

The type of lifestyle changes that may be beneficial depend upon the patient's age and symptom characteristics. Because few studies have examined the efficacy of lifestyle modifications in children and adolescents with GERD [1], recommendations are mostly extrapolated from studies in adults. Even in adults, there is limited evidence supporting efficacy for these interventions, as is discussed separately. (See ["Medical management of gastroesophageal reflux disease in adults". section on 'Lifestyle and dietary modification'.](#))

The following approaches have some benefit in adult patients with reflux, but have not been rigorously evaluated in children [1,3]:

- Weight loss or weight management for individuals who are overweight.
- Head of bed elevation – This is important for individuals with nocturnal or laryngeal symptoms, but its value for other situations is unclear.

The following lifestyle approaches also are used frequently. There is some evidence that these lifestyle changes improve laboratory measures of reflux (such as lower esophageal sphincter pressure), but no clinical evidence that they consistently improve reflux symptoms [1,3]:

- Dietary modification – Trial of avoidance of a core group of reflux-inducing foods, including chocolate, peppermint, and caffeinated beverages, that may reduce lower esophageal sphincter pressure. Acidic beverages, including colas and orange juice also may exacerbate symptoms. Avoidance of high fat foods is also recommended for adults because fat slows gastric emptying and thereby promotes reflux, although the benefit of reducing fat intake in children is unproven. Decisions about whether to restrict dietary fat also depend on the infant or child's overall nutritional status. Because sensitivity to each of these triggers varies among individuals, dietary restriction should be limited to those foods that are associated with symptoms in a specific patient.
- Positioning – Avoid the supine position soon after eating.
- Salivation – Promote salivation by either chewing gum or using oral lozenges. Salivation neutralizes refluxed acid, thereby increasing the rate of esophageal acid clearance.
- Alcohol and tobacco – Avoid alcohol and tobacco (including passive exposure to tobacco smoke). These substances reduce lower esophageal sphincter pressure, and smoking also diminishes salivation.

A number of lifestyle modifications also are used to manage GER in infants, including changes in feeding, positioning, and avoidance of tobacco smoke. These issues are discussed in detail in a separate topic review. (See "[Gastroesophageal reflux in infants](#)" and "[Gastroesophageal reflux in premature infants](#)".)

**PHARMACOTHERAPY** — Drugs that are used for treatment of gastroesophageal reflux disease (GERD) can be grouped into the following categories ([table 1](#)):

- Proton pump inhibitors (PPI)
- Histamine type 2 receptor antagonists (H2RA)
- Antacids
- Surface agents
- Prokinetics

The experience with each of these categories of drugs in children and adolescents is detailed in the following sections. Pharmacotherapy for gastroesophageal reflux (GER) in adults is discussed in detail separately. (See "[Medical management of gastroesophageal reflux disease in adults](#)".)

**Proton pump inhibitors** — PPIs block acid secretion by irreversibly binding to and inhibiting the hydrogen-potassium ATPase pump that resides on the luminal surface of the parietal cell membrane. The drugs in this class include [omeprazole](#), [lansoprazole](#), [rabeprazole](#), [pantoprazole](#), [esomeprazole](#) and [dexlansoprazole](#). The differences in pharmacology and efficacy among drugs in this class appear to be small and of uncertain clinical significance, thus it is reasonable to make treatment decisions based on cost and on which dosing formulation is accepted by the child. The pharmacology of PPIs and their efficacy in adults are discussed in detail separately. (See "[Proton pump inhibitors: Overview of use and adverse effects in the treatment of acid related disorders](#)".)

[Omeprazole](#), [esomeprazole](#), [lansoprazole](#) and [dexlansoprazole](#) have been most extensively studied in children and are approved by the US Food and Drug Administration (FDA) for this age group [1]. Approval updates and labeling changes are available on the FDA website [4].

**Efficacy** — The evidence for efficacy of PPIs depends on the patient population:

- **Esophagitis or marked GERD symptoms** – For treatment of endoscopy-proven peptic esophagitis and esophagitis-associated symptoms, we suggest use of a PPI rather than a H2RA. This suggestion is primarily based on randomized studies in adults, which demonstrated that PPIs are effective and superior to H2RAs [1,5]. As compared with H2RAs, PPIs produce a greater reduction in acid secretion, have a longer duration of action, and tolerance does not develop. (See "[Medical management of gastroesophageal reflux disease in adults](#)".)

Studies of PPIs in children and adolescents with esophagitis or marked GERD symptoms provide indirect evidence of their efficacy in this age group [6]. Several case series report that PPIs have healed severe esophagitis that had been unresponsive to H2RAs [7,8]. The only controlled trials compare PPIs with alternate forms of acid suppression. These demonstrated that PPIs were as effective as H2RAs for initial treatment of esophagitis [9], marked GERD symptoms [10], or maintenance of remission after initial treatment with PPIs [11].

Thus, available studies in children provide only indirect evidence of PPI efficacy because they are only shown to be equivalent to alternate acid-suppressing regimens for symptom relief and histologic healing, although PPIs are more effective in reducing gastric acidity [12]. Our suggestion that PPIs be selected in preference to other forms of acid suppression in patients with documented esophagitis is based on this indirect evidence and extrapolation from studies in adults, as well as observations that H2RAs are more likely to be associated with tachyphylaxis [1,13,14]. In addition, there may be better compliance with PPIs that can be given once daily as compared with multiple-dose regimens.

- **Asthma and other GERD manifestations** – The benefit of PPIs on extraesophageal manifestations of GERD in children such as asthma has not been well studied, although they are being used for this purpose in children based upon data in adults. (See '[Asthma with GER](#)' below and "[Gastroesophageal reflux and asthma](#)".)
- **Infants** – Several randomized trials and a systematic review concluded that PPIs are **not** valuable in infants with irritability or regurgitation, because they do not improve symptoms as compared with placebo [12,15-17]. However, PPIs or other acid-suppressing regimens are appropriate for an infant with marked histologic evidence of esophagitis on endoscopic biopsies; this is a rare occurrence in this age group. (See "[Gastroesophageal reflux in infants](#)", section on '[Pharmacotherapy](#)'.)

**Dosing** — Dosing guidelines for PPIs vary considerably. Infants and younger children appear to metabolize some PPIs more rapidly and may require higher per-kilogram dosing than older individuals ([table 1](#)) [1,18,19]. However, they should be used with caution in infants because of low efficacy in those with uncomplicated reflux symptoms, and also because the pharmacokinetics of PPIs may be affected by immature cytochrome metabolism in young infants [20,21]. In pediatric studies, effective doses of [omeprazole](#) ranged from 0.3 to 3.5 mg/kg/day (maximum 80 mg/day) and doses of [lansoprazole](#) ranged from 0.73 to 1.66 mg/kg/day (maximum 30 mg/day) [22]. However, there is little evidence to support doses of omeprazole over 40 mg daily for children, even for the treatment of documented esophagitis.

Some children may require twice daily dosing to achieve optimal acid suppression; we suggest starting with once daily dosing advancing to twice daily dosing if there is clear symptom improvement with the increased frequency. Some providers alternate doses of a PPI with a H2RA, but there is no specific evidence supporting this practice. The duration of therapy is two to four weeks for moderate to severe heartburn, and four to eight weeks for documented esophagitis. If the esophagitis is severe (erosive), we generally continue PPI treatment for three to six months followed by repeat endoscopy to assess for healing. (See '[Esophagitis](#)' below and "[Medical management of gastroesophageal reflux disease in adults](#)", section on '[Proton pump inhibitors](#)'.)

Several of these drugs are formulated as capsules containing enteric-coated granules that can be sprinkled onto soft foods for administration to young children. [Lansoprazole](#) and [omeprazole](#) are also available as flavored powders for preparing a suspension.

**Safety** — Although PPIs are generally well tolerated, long-term studies have raised concerns that long-term treatment with PPIs is associated with increased risk for some infectious, metabolic, and nutritional disorders. Most data on the long-term safety of PPIs are from studies in adults. Because of these safety concerns, patients treated with PPIs should be reevaluated on a regular basis to determine if ongoing use is necessary. In our practice, we attempt to wean patients from PPIs after six months of treatment, and then periodically thereafter, depending on symptom control. (See ['Discontinuing PPIs'](#) below.)

Potential safety concerns include an increased susceptibility to enteric infections, particularly *Clostridium difficile* (*C. difficile*) [23]. In 2012, the FDA issued a [Safety Alert](#) about this issue, encouraging providers to consider the possibility of *C. difficile*-associated diarrhea in PPI users with persistent diarrhea [24]. (See ["Clostridium difficile infection in children: Microbiology, pathogenesis, and epidemiology", section on 'Other risk factors'](#).)

Other safety concerns about PPIs include community-acquired pneumonia [25,26], vitamin B<sub>12</sub> or iron malabsorption, nephritis (reported in older adults), small intestine bacterial overgrowth [27], and hypomagnesemia due to reduced intestinal absorption [1]. A possible explanation for the infectious complications is supplied by a study reporting that treatment with acid-suppressing medications was associated with gastric bacterial overgrowth [28]. Moreover, patients on acid suppressing medications who experienced significant non-acid reflux also had higher bacterial concentrations in the lungs. Concerns about long-term effects on bone metabolism and chronic kidney disease have been raised based on studies in adults, but not established in children. (See ["Proton pump inhibitors: Overview of use and adverse effects in the treatment of acid related disorders", section on 'Adverse effects'](#) and ["Clinical manifestations and diagnosis of acute interstitial nephritis"](#) and ["Drugs that affect bone metabolism", section on 'Proton pump inhibitors'](#) and ["Small intestinal bacterial overgrowth: Etiology and pathogenesis"](#).)

Long-term use of PPIs may increase serum gastrin levels and induce mild enterochromaffin cell hyperplasia and/or atrophic gastritis, raising the theoretical concern that chronic PPI use might increase risks for gastric carcinoid tumors or colon cancer. However, no increased risk for cancer has been shown in studies in adults treated with PPIs for up to 11 years [29], or children treated for a median 2.8 years [30]. (See ["Proton pump inhibitors: Overview of use and adverse effects in the treatment of acid related disorders", section on 'Hypergastrinemia'](#).)

**Discontinuing PPIs** — Stopping PPIs is associated with acid rebound in which discontinuation causes a temporary increase in gastric acid output to levels higher than at baseline. The optimal management strategy to minimize problems with acid rebound has not been established. When attempting to discontinue PPIs in patients treated chronically, we and others gradually taper PPIs to minimize the potential problem of acid rebound [1]. However, a study of this type of tapering regimen in adults failed to establish a clinical benefit [31]. An alternate approach is to wean the patient initially to a H2RA. The evidence for acid rebound is from studies in adults, and is described in detail in a separate topic review. (See ["Proton pump inhibitors: Overview of use and adverse effects in the treatment of acid related disorders", section on 'Discontinuing PPIs'](#).)

**Histamine type 2 receptor antagonists** — For patients with mild or intermittent symptoms of GERD, we suggest a trial of histamine type 2 receptor antagonists (H2RAs) rather than PPIs or other drugs. H2RAs have moderate effects on GER, as measured by relief of symptoms and mucosal healing, but because they have a relatively rapid onset of action, they are well suited for providing symptomatic relief. However, they are somewhat less effective than the PPI class, especially for chronic use [1].

The H2RAs inhibit acid secretion by blocking histamine H<sub>2</sub> receptors on the parietal cell. Four H2RAs are available in the United States, in both prescription strength and a lower strength for non-prescription (over-the-counter) sales:

- [Cimetidine](#) (Tagamet)
- [Ranitidine](#) (Zantac)

- [Famotidine](#) (Pepcid)
- [Nizatidine](#) (Axid)

Multiple controlled trials in adults have evaluated the efficacy of H2RAs in adults [5]. These studies have shown that H2RAs are superior to placebo for healing esophagitis and improving symptoms, with little clinical difference among the formulations when dosed appropriately. However, their benefit is greatest for patients with mild esophagitis, and tolerance (tachyphylaxis) develops within days to a few weeks of beginning treatment, limiting efficacy for long-term management [1,14]. H2RAs reach peak onset of action about 2.5 hours after dosing, and the duration of action is 4 to 10 hours, so they are useful for on-demand treatment of occasional symptoms, or for short-term continuous use. (See "[Medical management of gastroesophageal reflux disease in adults](#)". section on 'Histamine 2 receptor antagonists'.)

Fewer studies have been performed in children, but the results are similar to the experience in adults. One study included 32 children (21 to 29 months) with esophagitis who were randomly assigned to receive [cimetidine](#) (30 to 40 mg/kg per day) or placebo [32]. After 12 weeks, healing was observed significantly more often in the cimetidine-treated group. Improvement of esophagitis was seen in all patients with mild or moderate esophagitis compared with only 57 percent of patients with severe esophagitis. Another trial included 26 children with endoscopically proven mild to moderate esophagitis who were randomly assigned to receive [nizatidine](#) (10 mg/kg per day in two doses) or placebo [33]. At the end of eight weeks, healing was observed significantly more often in children who received nizatidine (69 versus 15 percent), a response that also was reflected in decreased acid exposure as assessed by esophageal pH monitoring.

The use of H2RAs is associated with an increased risk of enteric infection, particularly *C. difficile* and community-acquired pneumonia [25] (see "[Clostridium difficile infection in children: Microbiology, pathogenesis, and epidemiology](#)", section on 'Other risk factors'). [Cimetidine](#) is a moderate inhibitor of Cytochrome P450 (CYP) metabolism and can increase levels of some co-administered medications, such as [theophylline](#), SSRIs, [warfarin](#) and cisapride. [Nizatidine](#), [ranitidine](#), and [famotidine](#) do not inhibit CYP metabolism or alter levels of co-administered drugs metabolized by CYP.

**Antacids** — Antacids are appropriate for short-term relief of heartburn in older children, adolescents, or adults with infrequent symptoms (less than once a week). Antacids begin to provide relief of heartburn within 5 minutes but have a short duration of effect of 30 to 60 minutes. The efficacy and safety of antacids have not been well-studied, and chronic use is generally not recommended, especially in infants due to potential complications such as hypophosphatemic rickets [34].

Antacids work by neutralizing gastric pH and thereby decreasing the exposure of the esophageal mucosa to gastric acidity during episodes of reflux. Various preparations that are commercially available usually contain the combination of magnesium and [aluminum hydroxide](#) or [calcium carbonate](#). At least two studies suggested that high-dose antacid therapy with magnesium/aluminum-containing acids was as effective as [cimetidine](#) for the short-term treatment of esophagitis in children [35,36]. However, treatment with aluminum-containing antacids can significantly increase plasma aluminum levels in infants to levels that have been associated with complications such as osteopenia, microcytic anemia, and neurotoxicity [37-39]. As a result, their use generally is restricted to short-term relief of symptoms in older children and adolescents [1]. The efficacy and safety of other types of antacids in children have not been well-studied. (See "[Antiulcer medications: Mechanism of action, pharmacology, and side effects](#)". section on 'Antacids'.)

**Prokinetics** — Prokinetic drugs have a very limited role in management of GERD because of significant safety concerns and limited efficacy [1]. Systematic reviews have not supported the use of [metoclopramide](#) [40], cisapride [41], or [domperidone](#) [6,42] for treatment of GERD [43]. These drugs should be considered for use only in carefully selected patients who have delayed gastric emptying because of gastric dysmotility (gastroparesis), contributing to GERD and in whom constipation has been ruled out as a confounding factor. [Erythromycin](#) also is used for patients with gastric dysmotility, such as post-viral gastroparesis, but its use is

limited by side effects and tachyphylaxis (tolerance). The use of these drugs for gastroparesis in adults is discussed in a separate topic review. (See "[Treatment of gastroparesis](#)".)

[Baclofen](#) is a gamma-amino-butyric acid B (GABA-B) receptor agonist that inhibits the transient relaxations of the lower esophageal sphincter that are a predominant mechanism of GER. A limited body of evidence in adults and children suggests that baclofen reduces reflux symptoms after acute or chronic dosing [44,45], reduces the frequency of esophageal sphincter relaxation and esophageal acid exposure, and accelerates gastric emptying [46,47]. Potential side effects include dyspepsia, drowsiness, and lowered seizure threshold [1]. Because of side effects, baclofen is rarely used to treat GERD in children without underlying neurological problems. However, it is occasionally used for children with cerebral palsy primarily to improve spasticity. (See "[Management and prognosis of cerebral palsy](#)", section on 'Oral antispastic drugs'.)

**Surface agents** — Surface agents work by creating a barrier that impedes acid peptic injury to mucosal surfaces. Only two such substances have been evaluated in the treatment of GERD: sodium alginate and [sucralfate](#). (See "[Medical management of gastroesophageal reflux disease in adults](#)", section on 'Surface agents and alginates'.)

[Sucralfate](#) (aluminum sucrose sulfate) adheres to the damaged mucosal surface, promoting healing and protecting from further peptic injury by mechanisms that are incompletely understood. A study in adults with non-erosive esophagitis found that it decreased symptoms and promoted healing [48]. One controlled trial in children suggested that it was as effective as [cimetidine](#) for treatment of esophagitis [49]. However, because of short duration of action, concerns related to aluminum toxicity and limited efficacy as compared with PPIs, sucralfate has a minimal, if any, role in the treatment of GERD in children or adults [1].

Sodium alginate, which is derived from seaweed, forms a surface gel that creates a physical barrier against regurgitation of gastric contents and protects the esophageal mucosa. Studies comparing its efficacy on symptoms and esophageal acid exposure with other available treatments have produced conflicting results [50-53]. It currently is used infrequently in the treatment of children with GERD. A preparation available in the United States (Gaviscon) also contains an antacid and is used for the temporary relief of heartburn in adults [54].

**Complementary and alternative medicine** — A variety of herbal remedies are sometimes used for acid reflux or other gastrointestinal complaints, including chamomile, slippery elm, and ginger root [55]. Many anecdotal reports suggest that these herbs sometimes improve symptoms, but no randomized controlled trials are available to guide their use. Since many families seek and use these remedies, it is important to inquire about their use in an open, non-judgmental fashion, and to review the specific remedies used for potential toxicities. The National Institutes of Health's (NIH) [National Center for Complementary and Integrative Health](#) provides reliable information on complementary and alternative medicine practices [56]. (See "[Complementary and alternative medicine in pediatrics](#)" and "[Overview of herbal medicine and dietary supplements](#)".)

**SURGERY** — Anti-reflux surgery appears to be successful in controlling reflux in many patients with debilitating gastroesophageal reflux disease (GERD) that is refractory to medical management, but the indications for and outcome of the intervention have not been systematically studied. Many children who have undergone anti-reflux surgery have underlying neurological impairment such as cerebral palsy. Surgery is most often considered for patients with intractable esophagitis or emesis that does not respond to proton pump inhibitors (PPIs), or pulmonary disease that is clearly due to aspiration from refluxed material. It may be challenging to discriminate pulmonary disease from aspiration associated with swallowing (antegrade aspiration) from that related to reflux (retrograde aspiration). The evaluation of children with suspected swallowing dysfunction is discussed separately. (See "[Aspiration due to swallowing dysfunction in infants and children](#)".)

The efficacy of surgery has been supported only by the results of numerous case series that used different inclusion criteria, focused predominantly on neurologically impaired children, had short follow-up periods,

and reported variable endpoints [57-64]. These limitations and the absence of controlled trials are critical impediments to defining the role of anti-reflux surgery in the long-term management of GERD in children. In addition, many case series report significant "failure rates" of anti-reflux surgery, mandating caution in selecting patients for this intervention. As an example, a large study of infants with neurological impairment undergoing gastrostomy placement found that concomitant fundoplication did not reduce the rate of reflux-related hospitalizations during the following year [65]. Alternatives to anti-reflux surgery that may be appropriate for some patients include nasojejunal or gastrojejunal feeding, which reduce reflux by bypassing the stomach. (See "[Aspiration due to swallowing dysfunction in infants and children](#)", section on '[Management](#)' and "[Overview of enteral nutrition in infants and children](#)", section on '[Poor gastric emptying or aspiration risk](#)'.)

Some children with neurological impairment and GERD may require percutaneous endoscopic gastrostomy (PEG) placement. Most children do well without a fundoplication. In a retrospective study [66], 5 percent of children with a normal pH probe prior to PEG placement, and 29 percent of children with an abnormal pH probe went to have a Nissen fundoplication. For such patients, it is reasonable to perform PEG placement without fundoplication, followed by medical anti-reflux therapy if clinically indicated, and fundoplication in the minority of patients who fail medical therapy.

**Technique** — The most commonly performed operation is a Nissen fundoplication. This procedure originally involved passage of the gastric fundus behind the esophagus to encircle up to 6 cm of the distal esophagus. However, many variations and modifications have been described, and a Nissen fundoplication may be performed differently by different surgeons. Variables include approach (transthoracic or abdominal), portion of stomach wall used (anterior and posterior or anterior only), combination with other procedures (eg, vagotomy or gastroplasty), the tightness of the wrap, the completeness (270° to 360°) of the wrap, and the length of the wrap.

The Nissen fundoplication is now performed laparoscopically at many centers. In experienced centers, the laparoscopic technique has similar outcomes to the open technique. Some studies suggest that laparoscopic surgery has fewer acute complications and incidence of retching and similar rates of complications [57,67-69], whereas a few report somewhat higher rates of reoperation and recurrence of GERD compared with open fundoplication [70-72].

Most surgeons choose to perform a loose ("floppy") Nissen fundic wrap that is approximately 1 to 2 cm in length, including a posterior crural repair. A common modification is a 360° fundic wrap without ligation of the short gastric vessels (Rosetti-Nissen) ([figure 1](#)). A partial 270° wrap (Toupet) is used for patients with severe associated motor abnormalities ([figure 2](#)) [59,62].

**Efficacy** — Symptom improvement has been described in approximately 60 to 90 percent of children undergoing fundoplication [1], but "failure rates" (variously defined) vary widely among reports, ranging from 2 to 50 percent [70]. As an example, in one study, nearly two-thirds of children had ongoing reflux, requiring treatment two months following fundoplication [63]. In studies that have reported longer-term outcomes, most demonstrate higher rates of failure within one to three years [73]. Several studies suggest higher failure rates in children with neurological impairment, chronic respiratory conditions, repaired esophageal atresia, and in infants [1,64,70,74]. Similar unsatisfactory outcomes were seen in a report of children with cystic fibrosis and GERD [75]. Nearly half of the children had ongoing symptoms of GERD after fundoplication, and overall there was little benefit to pulmonary function. Twelve percent of patients had complications that required a subsequent surgical procedure.

Experience in adults has demonstrated that patients who do not respond to adequate doses of medical therapy (particularly those with typical features of GERD, such as heartburn) also may have a poor response to surgery, questioning the role of anti-reflux surgery in patients with symptoms refractory to medical therapy. Furthermore, long-term follow-up of patients who underwent standard anti-reflux surgery reveals that even after surgery, many continue to depend upon medical therapy to control symptoms. (See "[Approach to refractory gastroesophageal reflux disease in adults](#)".)

**Complications** — Complications of anti-reflux surgery range from 2 to 45 percent [1,76,77]. The most common complications included breakdown of the wrap (1 to 13 percent), small bowel obstruction (1 to 11 percent), gas bloat syndrome (2 to 8 percent), infection (1 to 9 percent), atelectasis or pneumonia (4 to 13 percent), perforation (2 to 4 percent), persistent esophageal stricture (1 to 9 percent), and esophageal obstruction (1 to 9 percent). Complications that occurred less frequently included an incisional hernia, gastroparesis and dumping syndrome. Reoperation was required in 3 to 19 percent of patients, and operative mortality ranged from 0 to 5 percent. The presenting symptoms of dumping syndrome are often irritability after feeds, diaphoresis, or diarrhea; management is described separately. (See "[Enteral feeding: Gastric versus post-pyloric](#)", section on 'Feeding intolerance'.)

Patients with neurological impairment or those requiring a second anti-reflux operation appear to have somewhat higher frequency of complications [1,73]. However, children without underlying disorders also may have poor outcomes. Retching (dry heaves) is common in children who have undergone fundoplication, particularly children who are neurologically impaired [70,78]. The presence of preoperative forceful vomiting (versus effortless regurgitation) was a significant predictor of the development of postoperative retching [79]. Treatment for this complication is difficult, and if the retching is not controlled it may disrupt the surgical repair. Anticholinergic drugs and histamine type 1 receptor antagonists may be helpful [80]. Symptoms tend to improve after several months.

**Pre-surgical evaluation** — The diagnostic tests that may be used to help determine whether anti-reflux surgery is appropriate depend on the patient's clinical presentation. Causes of symptoms other than GERD should be rigorously excluded before considering surgical intervention.

- Children with chronic esophagitis unresponsive to acid suppression might be considered for anti-reflux surgery. However, they should first undergo an upper endoscopy with biopsies to exclude other causes of esophageal inflammation such as eosinophilic esophagitis and prolonged esophageal pH monitoring to confirm adequacy of acid suppression. (See "[Clinical manifestations and diagnosis of eosinophilic esophagitis](#)".)
- Children with primary respiratory symptoms should undergo evaluation to document association of GERD with respiratory symptoms. This evaluation may include review of all radiographic studies, bronchoalveolar lavage, esophageal pH monitoring, polysomnography, and swallowing studies. However, because even normal degrees of reflux may have adverse effects in some children, surgery may be beneficial for some children with respiratory symptoms even if the esophageal pH study is normal [81]. (See "[Clinical manifestations and diagnosis of gastroesophageal reflux disease in children and adolescents](#)".)
- If aspiration is suspected in a child with neurologic impairment, fundoplication should be approached with caution: although the fundoplication can reduce gastroesophageal reflux (GER), it can also impede esophageal clearance and increase the likelihood of aspiration. (See "[Aspiration due to swallowing dysfunction in infants and children](#)".)

**TREATMENT APPROACH BY PRESENTING SYMPTOMS** — The preceding discussion underscores the limited data available from well-designed controlled trials to guide optimal strategies for the management of gastroesophageal reflux disease (GERD) in children. However, in children with distinct symptoms of heartburn or documented esophagitis, the evidence base for treatment recommendations is analogous to and strengthened by observations in adults. The following recommendations are based upon a review of the available evidence by a committee of experts [1] and from clinical experience.

**Heartburn** — We employ a "step up" approach to simple heartburn symptoms, meaning that we start with conservative options and add more intensive therapy if needed. Patients with alarm symptoms (dysphagia, weight loss, hematemesis, or recurrent vomiting) in addition to heartburn should be referred to a gastroenterologist for an upper endoscopy with biopsy.

For children and adolescents with mild or infrequent heartburn (averaging once a week or less), we suggest a trial of lifestyle changes (weight management for overweight patients; smoking cessation and avoidance of tobacco smoke; head of bed elevation; and avoidance of chocolate, caffeine, spicy foods, alcohol, and other foods that exacerbate symptoms). Occasional use of antacids or histamine type 2 receptor antagonists (H2RAs) is acceptable for short-term relief of symptoms, but frequent use (more than once/week) calls for advancement of therapy [1,2]. (See ['Lifestyle changes'](#) above.)

If the heartburn symptoms are moderate or severe, or fail to respond to lifestyle changes, we recommend a trial of acid suppression therapy. Either a H2RA or proton pump inhibitor (PPI) is a reasonable first choice and a typical trial duration is two to four weeks [1,82]. However, for patients who do not improve on a H2RA, we recommend treatment with a PPI. (See ['Pharmacotherapy'](#) above and ["Clinical manifestations and diagnosis of gastroesophageal reflux disease in children and adolescents". section on 'Endoscopy and histology'](#).)

**Esophagitis** — We employ a "step down" approach to documented esophagitis, meaning that we initiate treatment with intensive pharmacotherapy (standard dose PPIs), then withdraw treatment as tolerated. This is similar to the approach used for adults with esophagitis, except that we tend to use somewhat longer courses of therapy in children, and are more likely to repeat the endoscopy.

For children with endoscopically documented peptic esophagitis, we recommend acid-suppressing treatment. We suggest using a PPI because these are more effective than H2RAs for initial healing of esophagitis [1,2]. Younger children appear to metabolize PPIs more rapidly and may require higher per-kilogram dosing than older individuals ([table 1](#)). (See ['Proton pump inhibitors'](#) above.)

Further evaluation and treatment of patients with esophagitis depends on the severity of the esophagitis at baseline and on the degree of symptom relief. Patients with only mild esophagitis can be treated for four to eight weeks, and reassessed based upon the degree of symptom relief. Those with erosive esophagitis should undergo a repeat endoscopy after three to six months of treatment [1]. The endoscopy is important to demonstrate healing, and also to reassess for the possibility of stricture or development of eosinophilic esophagitis (EoE). It may be difficult to distinguish peptic esophagitis (ie, esophagitis caused by acid reflux) from EoE, because both disorders are characterized by esophageal eosinophilia, and they have similar symptoms. Esophagitis that persists despite several months of effective acid suppression should raise suspicion for EoE. (See ["Clinical manifestations and diagnosis of gastroesophageal reflux disease in children and adolescents". section on 'Endoscopy and histology'](#) and ["Clinical manifestations and diagnosis of eosinophilic esophagitis"](#).)

Long-term treatment with acid suppressing medications is appropriate if symptoms or endoscopy indicate chronic or recurrent esophagitis, without suspicion for eosinophilic esophagitis. H2RAs are a reasonable choice if brief intermittent courses of treatment are sufficient to control symptoms. When continuous therapy is necessary to control symptoms, we suggest treatment with a PPI [1]. Because there are several safety concerns about long-term use of acid-suppressing medications, patients on continuous treatment should be reassessed periodically. A trial of discontinuing treatment should be considered if the symptoms are well controlled, unless the patient has a history of severe and recurrent esophagitis, or unless the endoscopy demonstrates Barrett esophagus [1]. (See ['Discontinuing PPIs'](#) above and ["Barrett's esophagus: Surveillance and management"](#).)

**Dysphagia or odynophagia** — Dysphagia (difficulty swallowing) may be caused by GERD, but also may have other causes, such as eosinophilic esophagitis, esophageal dysmotility, or foreign body. Children or adolescents with odynophagia (pain with swallowing) also should be evaluated for pill esophagitis (direct mucosal injury from swallowed irritant drugs) and infectious esophagitis caused by cytomegalovirus, herpes, or Candida. Children with either of these symptoms should have a careful evaluation, including an upper endoscopy if an infectious cause is suspected. Empiric treatment for reflux is not recommended unless other causes of the symptoms have been excluded. (See ["Clinical manifestations and diagnosis of gastroesophageal reflux disease in children and adolescents". section on 'Dysphagia or odynophagia'](#).)

## Extraesophageal manifestations of GERD

**Asthma with GER** — For patients with persistent moderate to severe asthma (particularly nocturnal wheezing) and clear symptoms suggesting GERD, including frequent heartburn or regurgitation, we suggest a trial of vigorous acid suppression. Treatment trials using a PPI for three months are often used in adults; management after three months depends upon the response. (See "[Gastroesophageal reflux and asthma](#)", section on '[Empiric therapy in patients with symptomatic GERD](#)'.)

This empiric approach to treatment is appropriate because although GER is an established trigger for asthma in many patients, it is difficult to predict responders [83]. In about 60 percent of children with asthma and clinical or laboratory evidence of GER, asthma control will improve with aggressive treatment for reflux [1,84]. In adults with GERD symptoms and moderate to severe asthma (or nocturnal asthma), randomized controlled trials of PPIs demonstrated small but significant improvements in peak flow or numbers of asthma exacerbations. (See "[Gastroesophageal reflux and asthma](#)", section on '[Evidence that GERD treatment improves asthma](#)'.)

In many patients with asthma, GERD may be silent and diagnosed only with esophageal pH monitoring. Thus, pH monitoring or an empiric trial of anti-reflux treatment should be considered in selected patients with asthma that is difficult-to-control (steroid-dependent) and/or nocturnal-onset, even in the absence of apparent symptoms of GERD [1]. Other causes of wheezing should be carefully excluded, including foreign body aspiration. (See "[Clinical manifestations and diagnosis of gastroesophageal reflux disease in children and adolescents](#)", section on '[Asthma](#)' and "[Evaluation of wheezing in infants and children](#)".)

There is inadequate evidence to determine the role of anti-reflux surgery for patients with asthma and GERD. Case series in adults and children generally report improvement in respiratory symptoms after fundoplication for selected patients with severe asthma, in whom a relationship to GERD is well established and there has been a clear response to acid suppressing medication [1,85-87]. Clinical findings predicting a positive response to surgery include a clear history of reflux symptoms preceding the onset of asthma, a history of recurrent pneumonia, lack of atopic symptoms or seasonal variation, and nocturnal episodes of asthma. However, these results should be interpreted with caution because of variations in selection criteria and lack of randomization in these studies. (See "[Surgical management of gastroesophageal reflux in adults](#)".)

**Recurrent pneumonia** — There are no definitive tests to determine whether GERD is causing recurrent pneumonia in a given patient. Clinical decisions must be based on an individual patient's clinical risk and a combination of tests for GER, aspiration, and immune deficiency. The possibility of antegrade aspiration (aspiration during swallowing) should be fully investigated, because this is a more common cause of recurrent pneumonia than retrograde aspiration (GERD) [1]. If the pneumonia is consistently in the same area, an H-type tracheo-esophageal fistula should be considered. (See "[Clinical manifestations and diagnosis of gastroesophageal reflux disease in children and adolescents](#)", section on '[Recurrent pneumonia](#)'.)

When aspiration and recurrent pneumonia are strongly suspected to be related to GERD, aggressive treatment is appropriate to prevent chronic progression of pulmonary disease [1,7]. If pulmonary disease is mild, medical treatment with acid suppression and/or prokinetic agents can be used, as long as pulmonary function can be monitored carefully in follow-up. If pulmonary disease is severe or progressive, surgical treatment with fundoplication should be considered. (See '[Surgery](#)' above.)

**INFORMATION FOR PATIENTS** — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5<sup>th</sup> to 6<sup>th</sup> grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more

detailed. These articles are written at the 10<sup>th</sup> to 12<sup>th</sup> grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see ["Patient education: Acid reflux \(gastroesophageal reflux disease\) in children and adolescents \(The Basics\)"](#))
- Beyond the Basics topics (see ["Patient education: Acid reflux \(gastroesophageal reflux disease\) in children and adolescents \(Beyond the Basics\)"](#) and ["Patient education: Acid reflux \(gastroesophageal reflux\) in infants \(Beyond the Basics\)"](#))

## SUMMARY AND RECOMMENDATIONS

- Lifestyle changes that may reduce gastroesophageal reflux (GER) include weight management in overweight patients, smoking cessation, elevation of the head of bed, and avoidance of chocolate, caffeine, spicy foods, alcohol, and other foods that exacerbate symptoms. Lifestyle changes as an initial approach to treatment for children and adolescents with mild or infrequent symptoms of GER, or as an adjunct to pharmacologic treatment in patients with moderate or severe symptoms suggestive of gastroesophageal reflux disease (GERD). (See ['Lifestyle changes'](#) above.)
- Lifestyle changes are an important component of managing reflux in infants. The evaluation and management of reflux in infants is discussed in a separate topic review. (See ["Gastroesophageal reflux in infants"](#).)
- Acid-suppressing medications are reasonably safe and effective for the treatment of established acid-related GERD. Proton pump inhibitor (PPI) medications are the most effective for short- or long-term acid suppression, but also are associated with acid rebound upon discontinuation, as well as some adverse effects with chronic use. Histamine type 2 receptor antagonists (H2RA) appear to be somewhat less effective than PPIs, but are less expensive. They are only useful for short-term acid suppression because tachyphylaxis (tolerance) develops within a few weeks. (See ['Proton pump inhibitors'](#) above and ['Histamine type 2 receptor antagonists'](#) above.)
- Prokinetic agents improve gastric emptying and/or the action of the lower esophageal sphincter, and could thus decrease both acidic and non-acidic gastric GER. However, the prokinetic agents that are currently available either have limited efficacy or significant safety concerns. Thus, we recommend NOT using prokinetic agents for the routine treatment of children with GER or GERD (**Grade 1B**). (See ['Prokinetics'](#) above.)
- For children or adolescents with mild or infrequent heartburn (averaging once a week or less), we suggest a trial of lifestyle changes (**Grade 2C**). Occasional use of antacids or H2RAs is acceptable for short-term relief of symptoms. If the heartburn symptoms are moderate or severe, or fail to respond to lifestyle changes, we recommend a trial of acid suppression therapy (**Grade 1A**). Either a H2RA or PPI is a reasonable first choice, and a typical trial duration is two to four weeks. Patients with alarm symptoms (dysphagia, weight loss, hematemesis, or recurrent vomiting), or those with persistent or recurrent symptoms on a PPI, should be referred to a gastroenterologist for an upper endoscopy with biopsy. (See ['Heartburn'](#) above.)
- For children with endoscopically documented peptic esophagitis, we recommend treatment with an acid-suppressing medication (**Grade 1A**). We also suggest a concurrent trial of lifestyle changes (**Grade 2C**). For initial treatment, we suggest a PPI rather than a H2RA (**Grade 2B**). Younger children appear to metabolize PPIs more rapidly and may require higher per-kilogram dosing than older individuals ([table 1](#)). (See ['Esophagitis'](#) above.)

- Further evaluation and treatment depends on the severity of the esophagitis at baseline and on the degree of symptom relief. Patients with only mild esophagitis can be treated for four to eight weeks, and reassessed based upon the degree of symptom relief. Those with erosive esophagitis should undergo a repeat endoscopy after three to six months of treatment. Surgery is a consideration for refractory cases but must be undertaken with caution because of substantial failure rates and rates of complications. There is not strong evidence that anti-reflux surgery prevents reflux-related complications in neurologically impaired children. (See '[Esophagitis](#)' above and '[Surgery](#)' above.)
- Dysphagia (difficulty swallowing) may be caused by GERD, but also may have other causes, such as eosinophilic esophagitis, esophageal dysmotility, or foreign body. Children or adolescents with odynophagia (pain with swallowing) also should be evaluated for pill esophagitis and infectious esophagitis. For children with these symptoms, we recommend a careful evaluation for other causes, including endoscopy, rather than empiric treatment for gastroesophageal reflux. (See '[Dysphagia or odynophagia](#)' above and "[Clinical manifestations and diagnosis of gastroesophageal reflux disease in children and adolescents](#)". section on '[Dysphagia or odynophagia](#)'.)
- In about 60 percent of children with asthma and clinical or laboratory evidence of GER, asthma control will improve with acid suppressing medication, but it is difficult to predict responders. Therefore, we suggest a three-month trial of a PPI for patients with persistent moderate to severe asthma (particularly nocturnal wheezing) **and** frequent heartburn or regurgitation suggesting GERD (**Grade 2B**). (See '[Asthma with GER](#)' above.)

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