INTRODUCTION — Infants put almost everything into their mouths, and toddlers eat just about anything. Of more than 100,000 cases of foreign body ingestion reported each year in the United States, 80 percent occur in children [1-4]. The majority of foreign body ingestions occur in children between the ages of six months and three years [1,5,6]. Fortunately, most foreign bodies that reach the gastrointestinal tract pass spontaneously. Only 10 to 20 percent will require endoscopic removal, and less than 1 percent require surgical intervention [1,5,7]. Although mortality from foreign body ingestion is extremely low, deaths have been reported [5,8,9].

In the United States, coins are the most common foreign bodies ingested by children. Other objects, including toys, toy parts, magnets, batteries, safety pins, screws, marbles, bones and food have been reported [3,7,10-12]. Ingestion of multiple foreign objects and repeated episodes are uncommon occurrences and usually occur in children with developmental delay [10,13].

CLINICAL MANIFESTATIONS — Most children with esophageal foreign bodies are brought to medical attention by their parents because the ingestion was witnessed or reported to them [1,5,14,15]. In these settings, they often are asymptomatic. As an example, in a case series only half of the children with an esophageal foreign body displayed symptoms at the time of the ingestion, such as retrosternal pain, cyanosis, or dysphagia, and in many of these cases the symptoms were transient [16].

When symptoms do occur, they are often related to the location of the foreign body. Older children may localize the sensation of something "stuck" to the neck or lower chest, suggesting irritation in the upper or lower esophagus, respectively. Patients of any age may present with refusal of feeds or dysphagia, drooling, or respiratory symptoms including wheezing, stridor, or choking.

Esophageal foreign bodies tend to lodge in areas of physiologic narrowing, such as the upper esophageal sphincter (cricopharyngeus muscle), the level of the aortic arch, and the lower esophageal sphincter [5,14]. Objects that appear in the middle portion of the esophagus are more likely to represent esophageal pathology, such as a stricture. Similarly, children presenting with food bolus impaction commonly have underlying esophageal pathology (eg, a stricture) directly responsible for the impaction [2,17]. Previous surgery or congenital malformations (eg, tracheoesophageal fistula) pose an increased risk as sites for obstruction [18,19].

Longstanding esophageal foreign bodies may cause weight loss or recurrent aspiration pneumonia, due to decreased caloric intake and mishandling of oral secretions, respectively. They can also damage the mucosa and lead to strictures, or erode the esophageal wall, creating a fistula with the trachea or other nearby structures. Sharp objects may perforate the esophagus, resulting in neck swelling, crepitus, or pneumomediastinum [5]. Erosion into the aorta also has been reported, causing life-threatening gastrointestinal bleeding [20,21].

APPROACH TO MANAGEMENT — A careful history and physical examination are the keystones to diagnosing an esophageal foreign body and to the prevention of its complications [22]. Imaging can be used to confirm the findings and to localize the site of the foreign body. The diagnostic steps and treatment depend on the patient's symptoms, the shape and location of the foreign body, and whether or not it is radiopaque (show algorithm 1) [23,24].

History and physical examination — Airway and breathing always should be examined first. The physical examination of the neck may reveal
swelling, erythema, or crepitus, suggesting esophageal perforation has occurred, and surgical consultation is mandatory. The chest examination may reveal inspiratory stridor or expiratory wheezing, suggesting a lodged esophageal foreign body with tracheal compression. The abdominal examination may show evidence of small bowel obstruction or perforation, in which case immediate surgical consultation and abdominal imaging should be obtained.

Diagnostic examination — For all patients with suspected foreign body ingestion, the initial diagnostic test should be biplane radiographs (anteroposterior and lateral) of the neck, chest, and abdomen [5,16,25]. Flat objects (eg, coins or disk batteries) usually orient in the coronal plane and appear as a circular object on an anteroposterior projection (show radiograph 1), whereas objects lodged in the trachea tend to orient in the sagittal plane and are best seen in lateral projection. However, these associations are not universal [26]. The lateral projection radiograph may help to identify the object or establish if more than one foreign body is present, such as stacked coins.

Toys made of plastic or wood, and many types of bones are not readily seen on plain films [16,27,28]. In a study of 325 children, only 64 percent of the ingested objects were radiopaque [16]. When the foreign body is not detected on plain film and a radiolucent foreign body is suspected, we suggest using computed tomography with 3 dimensional reconstruction as the next diagnostic procedure (show algorithm 1) [5,29].

We avoid gastrointestinal contrast studies when possible. Although the study may help identify the foreign body, barium contrast may obscure visualization on subsequent endoscopy. Moreover, the contrast may be aspirated if the esophagus is obstructed [20]. Because of these concerns, endoscopy may be preferred over contrast even if radiographs are negative [5,28].

A handheld metal detector has been employed with variable success in locating coins, and can detect materials that are metallic but not radiopaque, such as aluminum [30,31]. This instrument is less reliable in detecting metallic objects other than coins, limiting its use [32].

Urgent intervention — Urgent intervention is indicated if any of the following circumstances:

• The ingested object is sharp, long (>5 cm), with multiple magnets, and is in the esophagus or stomach.
• When a disk battery is in the esophagus (and in some cases in the stomach).
• When the patient shows signs of airway compromise.
• There is evidence of near-complete esophageal obstruction (eg, patient cannot swallow secretions).
• When there are signs or symptoms suggesting inflammation or intestinal obstruction (fever, abdominal pain, or vomiting) [5,28].

Expectant management — For blunt foreign bodies without the above characteristics that are lodged in the esophagus in an asymptomatic patient, observation for 12 to 24 hours is reasonable because spontaneous passage often occurs [2,33-37]. In one study, coins lodged in the esophagus passed spontaneously into the stomach in about one third of patients with a "simple" presentation (defined as no history of esophageal disease or surgery, coin lodged for less than 24 hours, and no respiratory compromise) [36].

Objects lodged for more than 24 hours or for an unknown duration should be removed promptly [5]. After this period, complications such as transmural erosion, perforation, and fistulae are more likely to occur. As an example, in a case series of 167 children, duration of lodgement for more than 24 hours was the strongest predictor of complications, which included injury to the esophageal mucosa, bleeding, stricture, and obstruction [20]. Complications also were more likely if the foreign body was a sharp or pointed object, disk battery, non-radiopaque, or located below the upper third of the esophagus.
TECHNIQUES—Various methods have been used to remove esophageal foreign bodies. They include rigid and flexible endoscopy, bougienage, Foley catheter, and the "penny pincher" technique.

Flexible endoscopy—Flexible endoscopy is preferred in most circumstances because the foreign body can be directly visualized and manipulated, and the surrounding gastrointestinal tract can be examined for potential complications [1,5,10,38-40]. This procedure is performed under conscious sedation or general anesthesia, depending upon the patient's age, ability to cooperate, and the type and number of objects to be removed [41,42].

Rigid endoscopy—Rigid endoscopy utilizes a non-flexible channeled device that is introduced into the esophagus under general anesthesia. It is most useful for impacted sharp objects that are located in the proximal esophagus, at the level of the hypopharynx and cricopharyngeus muscle [43]. The technique requires considerable skill, and may cause complications such as esophageal abrasion and perforation [10,40].

Magill forceps—Magill forceps can be used to extract foreign bodies impacted in the oropharynx or upper esophagus. In some cases, an object impacted in upper esophageal sphincter is visible at the time of tracheal intubation and can be directly removed with the Magill forceps without the need for intubation. However, in most cases, an endotracheal tube is placed to protect the airway, and a laryngoscope is used to gently open the esophagus and visualize the foreign body [16,44].

Bougienage—Bougienage (passage of a dilator) has been used to push objects into the stomach. Although the procedure is less costly than endoscopy, it does not permit visualization of the esophagus and does not retrieve the foreign body. Many providers do not recommend it at all if endoscopy is available [5,16,39].

Foley catheter—A deflated foley catheter is passed beyond the foreign body. The balloon is then inflated using a radioopaque contrast dye, and the catheter is slowly drawn back under fluoroscopic guidance, to remove the foreign body through the mouth. The technique can be successful with proximal esophageal foreign bodies when performed by an experienced operator. It does not permit visualization of the esophagus and carries the risk of esophageal perforation if the balloon is inflated below a stricture. This approach may cause aspiration of the foreign body if it is inadvertently dragged into the trachea [5].

APPROACHES FOR SPECIFIC TYPES OF FOREIGN BODIES

Coins—Coins are by far the most common foreign body ingested by children [1,20,39,46]. A small percentage of the ingested coins become lodged in the esophagus, and these can cause serious complications including aspiration if not removed [46]. Approximately two thirds of ingested coins are in the stomach at the time of initial radiographic evaluation [12,46].

If a coin is visualized in the esophagus, and the patient is asymptomatic, the child can be observed for up to 24 hours after ingestion of the coin. In such patients, 20 to 30% of coins will pass into the stomach spontaneously during the observation period (two-thirds of these during the first eight hours). Spontaneous passage is more common in older children and when coins are located in the distal third of the esophagus.

The esophageal coin should be removed promptly if the patient is symptomatic, if the coin does not pass spontaneously by 24 hours after ingestion, or if the time of ingestion is not known. In our practice, we prefer to remove most coins using flexible endoscopy. Rigid endoscopy or Magill forceps are acceptable approaches for proximally located coins, with experienced operators.

Because coins lack sharp edges and the metal is not toxic, coins that reach the stomach can be managed expectantly, and most will pass out uneventfully within one to two weeks. For these patients, most providers check the location of the coin with a plain radiograph about once a week. If the coin has not passed beyond the stomach by
four weeks, endoscopic removal is recommended. If the child develops any signs or symptoms of obstruction, abdominal pain, vomiting, or fever, then the patient is promptly reevaluated with radiographs and the coin is removed endoscopically. Although there have been theoretical concerns about zinc toxicity from retained gastric pennies minted after 1982, evidence demonstrating the need for extraction is lacking [1,16,39,47].

Disk batteries — A disk or "button" battery lodged in the esophagus is a medical emergency. Contact of the flat esophageal wall with both poles of the battery conducts electricity, which can rapidly result in liquefaction necrosis and perforation of the esophagus. Retained batteries also can cause problems by the leakage of caustic material (generally batteries contain a heavy metal like mercury, silver, lithium and a strong hydroxide of sodium or potassium) [5,6,20,28]. It may be difficult to differentiate between a disk battery and a coin on a radiograph. This distinction is most important when the foreign body is in the esophagus, since batteries require immediate removal whereas coins may or may not. Like coins, most disk batteries pass harmlessly once they reach the stomach. However, because of the potential for direct mucosal injury and toxicity, batteries should be removed from the stomach under certain conditions.

Sharp-pointed objects — The most common sharp-pointed objects ingested by children are straight pins, needles, and straightened paper clips; these represent 5 to 30 percent of swallowed objects [1,20]. Sharp-pointed objects lodged in the esophagus represent a medical emergency (risk of perforation ~15 to 35 %) [1,20]. When lodged in the hypopharynx, they can cause a retropharyngeal abscess [16]. Children suspected of swallowing sharp-pointed objects must be evaluated to determine the location of the object. If the history or examination raises concern for a sharp pointed object, endoscopy should be performed even if the radiologic exam is negative, because many sharp-pointed objects are not readily visible by x-ray.

If the object is in the esophagus, it should be removed immediately [24]. The risk of mucosal injury during retrieval of a sharp object can be minimized by orienting the object with the sharp-end trailing during extraction and using a protector hood on the end of the endoscope, or (in older children) an overtube [23,48]. If the object is in the stomach or proximal duodenum, it should also be removed promptly, using a flexible endoscope. The risk of a complication caused by a sharp-pointed object passing through the gastrointestinal tract is as high as 35 percent [17], although some case series describe lower complication rates from sharp objects (4 percent) [49]. Sharp objects that pass beyond the reach of a flexible endoscope and then cause symptoms will require surgical intervention.

If the object has passed into the small intestine and the patient is asymptomatic, it may be followed with serial radiographs to document its passage. Surgical intervention should be considered for objects that fail to progress for three consecutive days [2]. Parents are instructed to report immediately abdominal pain, vomiting, fever, hematemesis, or melena.

Magnets — With the increasing use of small magnets in toys and household items, ingestion of magnets is becoming a problem in children [61-64]. These magnets usually come in the form of small cylinders or balls. Many of the children with complications of multiple magnetic ingestion had underlying conditions such as developmental delay or autism [61,62]. A single ingested magnet with smooth edges presents little risk, but two or more magnets may attract across layers of bowel leading to pressure necrosis, fistula, volvulus, perforation or obstruction. As a result, it is of utmost importance to determine the location and number of magnets after a suspected ingestion, and
ingestion of multiple magnets warrants preemptive removal [63,65].

**Long objects** — Foreign bodies that are long and blunt, such as toothbrushes, batteries, and spoons, are most frequently ingested by older children, adolescents, or adults. Objects longer than 6 to 10 cm generally cannot pass beyond the stomach and should be removed [28,49,66]. Objects of intermediate length (over 5 cm) may pass the stomach but up to 50 percent become impacted in the ileocecal region [49]. Thus, these should be removed promptly if they are in the stomach. If they pass into the small intestine they should be followed by serial radiographs, and surgical removal should be considered if they fail to progress.

**SUMMARY AND RECOMMENDATIONS**

- Many children with esophageal foreign bodies are asymptomatic or had transient symptoms at the time of the ingestion, such as retrosternal pain, cyanosis, or dysphagia. When symptoms do occur, they may include a sensation of something stuck in the chest, refusal of feeds or dysphagia, drooling, or respiratory symptoms.
- Patients with long-standing esophageal foreign bodies may present with weight loss, aspiration pneumonia, fever, or signs and symptoms of perforation including gastrointestinal bleeding or pneumomediastinum.
- The initial evaluation of a patient with suspected foreign body ingestion should include biplane radiographs (anteroposterior and lateral) of the neck, chest, and abdomen. Other imaging modalities or direct advancement to upper endoscopy may be helpful in identifying radiolucent foreign bodies.
- Urgent intervention to remove a foreign body is indicated in the following situations:
  - When the object is a sharp, long, or consists of multiple magnets.
  - When the object is a disk battery and is in the esophagus.
  - If airway compromise, such as tracheal compression, is present.
  - If there is evidence of esophageal obstruction (eg, unable to swallow secretions).
  - If there are signs or symptoms suggesting inflammation or intestinal obstruction (fever, abdominal pain, or vomiting).
  - If the object is in the esophagus and the suspected ingestion occurred 24 or more hours prior to the evaluation, or if the time of ingestion is unknown.
  - For patients without the above characteristics who are comfortable and able to handle oral secretions, intervention can be delayed for up to 24 hours. Coins, food impactions, and other blunt objects often will pass spontaneously into the stomach and beyond. Recommendations for removal of disk batteries that are in the stomach depend on the timing of ingestion and composition of the battery.
  - A variety of techniques are used to extract foreign bodies from the esophagus or stomach. We suggest flexible endoscopy for most foreign body extractions (Grade 2C). This preference is because the technique can be adapted to a variety of foreign bodies in the esophagus, stomach, or proximal duodenum, and allows direct assessment of the mucosa for injury. Rigid endoscopy or retrieval with Magill forceps are useful techniques for objects in the hypopharynx or proximal esophagus.
  - We recommend prompt removal of any sharp object in the esophagus (Grade 1B) or proximal gastrointestinal tract (Grade 1C). This is because of high rates of complications from sharp objects. For the same reason, we recommend prompt removal of magnets if more than one is present in the proximal gastrointestinal tract (Grade 1C). If these objects have passed beyond the proximal duodenum and the patient is asymptomatic, they can be managed with close observation and serial radiographs.
  - Objects that have passed beyond the proximal duodenum are not accessible to the endoscope, and most will pass without complications. The progress of radioopaque objects down the gastrointestinal tract should be monitored with serial radiographs.
REFERENCES

17. Macmanus, JE. Perforation of the intestine by ingested foreign bodies. JAMA 1941; 53:393.
55. Holsinger, JW, Furson, RL, Sealy, WC. Esophageal perforation following meat impaction and papain ingestion. JAMA 1968; 204:188.