American College of Radiology
ACR Appropriateness Criteria®

Ingested or Aspirated Foreign Body-Child

Variant: 1 Child. Suspect ingested or aspirated foreign body. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography neck chest abdomen and pelvis	Usually Appropriate	☢☢☢
Radiography chest	Usually Appropriate	☢
Radiography neck	Usually Appropriate	☢☢
Radiography abdomen and pelvis	Usually Appropriate	☢☢☢
Fluoroscopy single contrast esophagram	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate	☢☢☢☢
Radiography chest decubitus view	Usually Not Appropriate	☢
US abdomen	Usually Not Appropriate	O
Radiography abdomen	Usually Not Appropriate	☢☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 2 Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.

Procedure	Appropriateness Category	Peds Relative Radiation Level
CT chest without IV contrast	Usually Appropriate	☢☢☢☢
US abdomen	May Be Appropriate	O
Fluoroscopy single contrast esophagram	May Be Appropriate	☢☢☢
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢☢
CT chest abdomen pelvis without IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 3 Child. Suspect aspirated foreign body. Initial radiographs negative. Next imaging study.

Procedure	Appropriateness Category	Peds Relative Radiation Level
CT chest without IV contrast	Usually Appropriate	☢☢☢☢
Radiography chest decubitus view	Usually Not Appropriate	☢
Fluoroscopy single contrast esophagram	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Panel Members

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Summary of Literature Review

Introduction/Background

Ingestion or aspiration of foreign bodies is a common primary complaint in many emergency departments across the United States, with an estimated 116,000 new cases reported per year [1-4]. The American Association of Poison Control reports the highest incidence of cases includes children 6 months to 5 years of age [2]. The most frequently ingested foreign bodies are coins, which are radiopaque on radiographs and typically pass through the gastrointestinal (GI) tract without complications. However, in 10% to 20% of cases, surgical or GI consultation is required, especially when objects become lodged in the esophagus [1,5,6].

Ingested objects such as batteries or sharp items present a broader range of risks, varying from complete resolution of symptoms to life-long complications and even death [7]. Additionally, some foreign bodies, such as impacted food, may be radiolucent, requiring further imaging beyond initial radiographs. Special consideration should be given to younger as well as nonverbal pediatric patients, in whom assessment and differentiation between ingested or aspirated foreign bodies could be challenging. In such cases, additional imaging may be required beyond the initial radiographs.

Symptoms of foreign body ingestion can vary widely, ranging from mild to severe, and may present either acutely or chronically. They may include dysphagia or, in the most severe cases, aortoesophageal fistulas and death.

Lithium batteries, commonly found in toys, watches, and remote controls, are a well-known cause of caustic esophageal injury, which can lead to complications such as perforation, mediastinitis, and abscesses. The incidence of battery-related injuries has increased in recent decades, likely due to their larger size (increasing the likelihood of esophageal impaction) and higher voltage [7-9].

Sudden onset of dysphagia after food ingestion is the typical presentation symptom of food impaction. In these situations, the impaction may prevent other foods or liquid passage requiring

removal. This condition tends to affect children beyond the infancy period, yet the prevalence in the pediatric population has not been well established in the literature [10]. In adults, the incidence has been reported to affect 13 per 100,000 adults [11,12]. The etiologies of food impaction widely studied in children include eosinophilic esophagitis most commonly, followed by prior esophageal atresia repair and Nissen fundoplication [10,11,13,14]. Behavioral factors need to also be considered as an etiology of food impaction secondary to incomplete chewing and eating quickly. Following initial radiographs, fluoroscopy (upper GI [UGI] imaging or esophagram) has previously been frequently requested by emergency or GI providers in many clinical practices. The diagnostic imaging paradigm, however, is shifting [10]. The development and expansion of pediatric focused evidence-based literature and clinical practices is progressively replacing fluoroscopy studies by noncontrast low-dose CT.

Aspirated foreign bodies can pose significant diagnostic challenges, as the aspiration event may go unwitnessed and symptoms may present later. Children <3 years of age are especially susceptible due to their natural curiosity, limited ability to chew food due to a lack of molars, and relatively immature swallowing mechanisms [6]. Most aspirated foreign bodies are found in the right main stem bronchus at bronchoscopy [15]. Commonly aspirated objects in this age group include foods such as peanuts and sunflower seeds, whereas older children tend to aspirate nonorganic objects such as plastic or LEGO pieces [6,16,17]. Symptoms of aspiration may be vague, ranging from acute or chronic wheezing and coughing to recurrent pneumonia. As aspirated foreign bodies are often radiolucent, diagnosis typically relies on indirect radiographic findings combined with clinical presentation. Recent advancements in low-dose CT protocols now allow for prompt and direct visualization of foreign bodies in the airway, aiding in quicker diagnosis [18,19].

The initial diagnosis and management of these patients should begin with a thorough clinical history and physical examination. Appropriate imaging modalities can then significantly assist frontline providers in diagnosing and managing patients with ingested or aspirated foreign bodies. This document will discuss the appropriateness of different imaging modalities in the evaluation of ingested or aspirated foreign bodies addressing 3 different variants: 1) Child with suspected ingested or aspirated foreign body. Initial imaging; 2) Child with suspected ingested foreign body. Initial radiographs negative. Next imaging study; and 3) Child with suspected aspirated foreign body. Initial radiographs negative. Next imaging study.

Special Imaging Considerations

Diagnosing aspirated foreign bodies with laryngoscopy or bronchoscopy is considered the reference standard; however, both have high false-negative rates and additional risks associated with surgery and anesthesia [19]. Low-dose CT without intravenous (IV) contrast has emerged in the last decade as an established modality to further evaluate aspirated or ingested foreign bodies for which radiographs are not sufficient to elucidate the foreign body [4,18-21]. CT is particularly helpful to identify radiographically occult foreign bodies such as food or plastic objects [22]. Because the low-dose CT protocol does not require IV or oral contrast, it can often be rapidly performed without the difficulties of IV placement in children. Multiplanar reformatted images are important for detection and 3-D "virtual bronchoscopy" reconstructions, as well as the minimum intensity projections reconstructions are particularly helpful to identify filling defects in the airway and bronchial tree lumen.

CT radiation doses should follow the principle of as low as reasonably achievable (ALARA). A meta-

analysis by Azzi et al [23] noted that reported effective doses ranged from 0.04 mSv to 2 mSv. Full discussion of radiation dose is beyond the scope of this document; however, pediatric relative radiation levels are included. Gordon et al [24] compared the diagnostic performance of an ultralow-dose CT (dose length product ~1 mGy/cm) with that of radiographs and fluoroscopy in the diagnosis of foreign body aspiration (FBA) in children. They found that the ultralow-dose CT doses (0.04 mSv) were significantly lower compared with those of radiographs and fluoroscopy (0.1 mSv) ($P < .001$) and that the sensitivity and specificity were higher for ultralow-dose CT (100% and 98%, respectively) compared with the other methods (33% and 96%, respectively).

Evaluation of food impacted in the esophagus has also been evaluated with single-contrast fluoroscopy studies such as an esophagram or UGI series. The terminology "UGI" and "esophagram" are often used with considerable overlap in literature and clinical practice; therefore, precision is advised during image acquisition. If a complete UGI series is performed, the UGI is often primarily focused on the esophagus, similar to esophagram, rather than the stomach or duodenum. Furthermore, fluoroscopy is not required if the clinical presentation is typical and should not delay endoscopy with removal of impacted bolus.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.

The goal of imaging is to identify the presence and location of a swallowed or inhaled foreign object in children when there is clinical suspicion. The information obtained by radiologic evaluation aids clinicians to determine the next steps on patient's management including removal of the object or follow-up imaging until self-eliminated. Prompt identification of the ingested or aspirated foreign body decreases the rate of potential complications such as infection, bowel perforation, and fistulas.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
A. CT abdomen and pelvis with IV contrast

There is no relevant literature to support the use of CT abdomen and pelvis with IV contrast in the initial evaluation of suspected ingested or aspirated foreign bodies in children.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast in the initial evaluation of suspected ingested or aspirated foreign bodies in children.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
C. CT abdomen and pelvis without IV contrast

There is no relevant literature to support the use of CT abdomen and pelvis without IV contrast in the initial evaluation of suspected ingested or aspirated foreign bodies in children.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
D. CT chest abdomen pelvis with IV contrast

There is no relevant literature to support the use of CT chest, abdomen, and pelvis with IV contrast in the initial evaluation of suspected ingested or aspirated foreign bodies in children.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
E. CT chest abdomen pelvis without and with IV contrast

There is no relevant literature to support the use of CT chest, abdomen, and pelvis without and with IV contrast in the initial evaluation of suspected ingested or aspirated foreign bodies in children.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
F. CT chest abdomen pelvis without IV contrast

There is no relevant literature to support the use of CT chest, abdomen, and pelvis without IV contrast in the initial evaluation of suspected ingested or aspirated foreign bodies in children.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
G. CT chest with IV contrast

There is no relevant literature to support the use of CT chest with IV contrast in the initial evaluation of suspected ingested or aspirated foreign bodies in children.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
H. CT chest without and with IV contrast

There is no relevant literature to support the use of CT chest without and with IV contrast in the initial evaluation of suspected ingested or aspirated foreign bodies in children.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
I. CT chest without IV contrast

When children present to the emergency department with a history of choking, coughing, or a witnessed aspiration event, the concern for FBA is high. Bronchoscopy is considered the reference standard for diagnosing, despite its high false-negative rates. In the past decade, CT has emerged as a valuable initial imaging modality to evaluate for foreign bodies in the tracheobronchial tree, potentially reducing the need for unnecessary bronchoscopy [18,19,25,26]. New low-dose CT protocols now provide detailed imaging of the entire tracheobronchial tree, pulmonary parenchyma, and pharyngeal region. In some institutions, clinical diagnostic pathways have been created, in which a limited z-axis (from the larynx to the proximal segmental bronchi of the lower lungs) low-dose CT is initially obtained in the workup of this patient population [25].

The ability to rapidly acquire pediatric optimized noncontrast CT coupled with the high diagnostic performance, has made CT a very useful tool for the initial evaluation of patients with suspected FBA [19,27-29]. The images can be reformatted in multiple planes, using minimum intensity

projection, and postprocessed to create “3-D-virtual bronchoscopy,” further reducing the need for unnecessary bronchoscopy.

A recent meta-analysis of 16 studies involving 2,056 pediatric patients found that CT had a sensitivity of 98.8% and a specificity of 96.6% for diagnosing FBA [23]. When 3-D virtual bronchoscopy was added, the sensitivity and specificity increased to 99.4% and 99%, respectively. The same meta-analysis reported a low CT false-positive rate (1.5%) and false-negative rate (0.5%). Another meta-analysis involving 4,178 patients reported a sensitivity and specificity of 99% and 92%, respectively, with a false-negative rate of 1.8% [29]. Similarly, other smaller but more recent studies have reported a similarly high sensitivity (100%) and specificity (85.7%) in the CT detection of FBA.

The usefulness of 3-D CT reconstructions in diagnosing FBA has also been evaluated [16,30,31]. A study by Yang et al [16], reported a diagnostic accuracy with a sensitivity of 99.83% and a specificity of 99.89%, with the most commonly aspirated foreign bodies being peanuts and sunflower seeds. Along with others [18,30], they concluded that acutely ill patients or those with clear clinical evidence of FBA should be taken directly to the operating room rather than delaying care by obtaining CT or other imaging.

Pediatric patients have unique needs that require specially tailored CT protocols distinct from those used for adults. It is crucial for institutions to follow the ALARA principle and adhere to ACR guidelines to minimize radiation exposure [22]. The development of newer low-dose chest CT protocols is a prime example of how pediatric imaging can be optimized for safety without compromising diagnostic quality.

Based on the literature, CT of the chest may be considered for evaluating suspected pediatric FBA in cases in which clinical suspicion is low or unclear, there is no respiratory distress, and a prior chest radiograph is unrevealing. Historically, the imaging evaluation of children presenting with symptoms concerning for ingested esophageal foreign bodies has been performed using radiographs. However, some radiolucent foreign bodies may not be detected by this modality, requiring further evaluation with a fluoroscopic esophagram. In the adult population, CT has been increasingly used in place of fluoroscopy [32-34] or radiographs with reported a sensitivity of 100%, a specificity of 92.6%, a negative predictive value of 100%, and a positive predictive value (PPV) of 97.9% [35].

Low-dose CT offers many advantages over esophagram including consistent, nonoperator-dependent image acquisition; rapid performance; not requiring IV or oral contrast; reducing the risk of aspiration with oral contrast; and requiring less patient cooperation [21].

Thus, CT has emerged as a very useful tool in the evaluation of ingested foreign bodies in the pediatric population and has been implemented at multiple institutions as the first-line imaging modality for the diagnosis of radiolucent ingested foreign bodies [4,21].

The use of oral contrast in low-dose chest CT has primarily been studied in adults, particularly in cases of suspected esophageal perforation, rather than for initial imaging evaluations due to the risk of potential aspiration [36]. Currently, there are no data supporting the use of oral contrast in CT imaging for this purpose in the pediatric population.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
J. Fluoroscopy single contrast esophagram

Esophagram has been the most prevalent modality used in the evaluation of pediatric esophageal food impaction [21,37,38] and the second line of evaluation when the initial radiographs failed to demonstrate an abnormality and the clinical concern for food impaction is high [11]. If the clinical presentation is typical, fluoroscopy may not be necessary and should not delay endoscopy with removal of impacted bolus [11].

Esophagrams do carry their own inherent risks. The oral contrast required for this examination poses a risk for aspiration and may interfere with subsequent procedures such as endoscopy or foreign body removal [39]. Although oral contrast has the risk of potential aspiration, some adult studies have reported on the improved value of CT administering oral contrast [36,40]. Fluoroscopy may fail to diagnose other causes of the patient's symptoms [36,39,41,42].

Increasingly, the literature supports the usefulness of noncontrast chest CT for the diagnosis of ingested foreign bodies in adult and pediatric patients; however, no current guidelines for the pediatric population exist to date. Despite this, some sites have adopted CT and have reported that CT has become the first line of evaluation replacing esophagrams [4,21].

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
K. Fluoroscopy upper GI series

A complete UGI fluoroscopy series is rarely performed and has been mostly replaced by a fluoroscopy esophagram. If the concern is for an ingested foreign body below the level of the esophagus and proximal to the ligament of Treitz, then a complete UGI series may be warranted. However, in these instances, endoscopy with removal may take priority.

Esophagram has been the most prevalent modality used in the evaluation of pediatric esophageal food impaction [21,37,38] and the second line of evaluation when the initial radiographs failed to demonstrate an abnormality and the clinical concern for food impaction is high [11]. Yet, authors have advocated that fluoroscopy is not required if the clinical presentation is typical and should not delay endoscopy with removal of impacted bolus [11].

Sudden onset of dysphagia after food ingestion is the typical presentation symptom of food impaction. In this situation, the food impaction prevents other foods or liquids to pass through and needs to be emergently removed. This tends to affect children beyond the infancy period; however, the prevalence in the pediatric population has not been well established in the literature [10]. In adults the incidence has been reported to affect 13 per 100,000 adults [11,12]. The reasons for food impaction have been studied with eosinophilic esophagitis found to be the most common, followed by prior esophageal atresia repair, and Nissen fundoplication [10,11,14].

Behavioral factors need to also be considered as an etiology of food impaction, likely secondary to incomplete chewing and eating quickly. Although fluoroscopy is not required to reach the proper diagnosis, it is frequently requested by emergency department or GI providers and in most clinical practices, it precedes endoscopic evaluation and removal [10].

Esophagrams carry their own inherent risks. The oral contrast required for this examination poses a risk for aspiration and may interfere with subsequent procedures such as endoscopy or foreign

body removal [39].

Gastrografin should be avoided in children due to risk of aspiration. Although oral contrast has the risk of potential aspiration, some adult studies have reported on the improved value of CT administering oral contrast [36,40].

Fluoroscopy may fail to diagnose other causes of the patient's symptoms [4,36,39,41,42].

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
L. Radiography abdomen

There is no relevant literature to support the use of isolated abdomen radiographs in the initial evaluation of suspected aspirated foreign bodies in children. Radiographs of the abdomen are typically obtained in conjunction with radiographs of the neck, chest, and pelvis as the very initial radiologic evaluation for ingested foreign bodies. In most instances, the abdomen and pelvis can be acquired as one anteroposterior view due to the small size of children, which fit into one radiographic field of view. Single abdomen and pelvis radiographs are typically obtained to follow the initial diagnostic radiograph where the foreign body is identified and to evaluate for progression through the GI tract.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
M. Radiography abdomen and pelvis

There is no relevant literature to support the use of isolated abdomen and pelvis radiographs in the initial evaluation of suspected aspirated foreign bodies in children. Radiographs of the abdomen and pelvis are typically obtained in conjunction with radiographs of the neck and chest as the very initial radiologic evaluation for ingested foreign bodies. In most instances, the abdomen and pelvis can be acquired as one anteroposterior view due to the small size of children, which fit into one radiographic field of view. Single abdomen and pelvis radiographs are sometimes obtained to follow the initial diagnostic radiograph where the foreign body is identified and to evaluate for progression through the GI tract.

Radiographs have a nearly 100% PPV when the suspected ingested foreign body is of radiopaque material such as coins or batteries [21]. But its ability to visualize other objects such as plastic, glass, or those organic in nature is limited [21]. In these instances, fluoroscopy and CT without IV contrast will play an important role because they have the ability to visualize these objects [12,37,38,43]. NASPGHAN recommends radiographs as the first imaging modality for suspected foreign body ingestion [12]. Metallic foreign objects such as coins (not button batteries) may be treated with expectant management, and serial radiographs may be obtained to evaluate for progression through the GI tract [12].

Lateral abdomen radiographs may be worthwhile for evaluation of intestinal obstruction in the setting of ingested foreign body and in the evaluation of free air secondary to bowel perforation. The lateral decubitus view is especially helpful in detecting small amounts of free air, which may not be easily seen on other projections.

Additionally, this technique can help identify the precise location of the foreign body, especially if it has migrated.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
N. Radiography chest

In cases of suspected ingested foreign body, chest radiographs will be typically obtained along with neck, abdomen, and pelvis radiographs. Radiographs have a high sensitivity and PPV in the diagnosis of foreign bodies of radiopaque material [21,43,44].

The most commonly ingested foreign body in children are coins (pennies) and they are typically lodged at the superior esophagus. Magnets and button batteries are additional commonly swallowed objects and have been on the rise for the last decade [45]. If a radiopaque foreign body is visualized in the initial frontal radiograph, a lateral radiograph should promptly follow, as the conjunction of frontal and lateral radiographs of the chest can be helpful to differentiate the coins from button batteries and other ingested objects. Button batteries will show a symmetrically circumferential double rim, whereas coins will show a single rim. On the lateral projection, they will be seen in a more linear configuration in which the button batteries will have a bilaminar or step-off appearance. If more than 1 coin is swallowed and stacked together, the lateral view would be beneficial in differentiating the 2 by an asymmetric edge [17,46]. Esophageal coins will typically appear en face on the frontal radiographs. Rarely, coins en face on the lateral projection and linear on the frontal may be in the airway. Studies have demonstrated high sensitivity and accuracy in the differentiation of coin versus button batteries by radiographs [47], and therefore when batteries are diagnosed by radiographs, prompt treatment should follow and no further imaging is recommended.

Patients who ingested radiolucent objects may benefit from different evaluation methods such as low-dose CT or esophagram.

In the setting of a suspicion of upper airway FBA or ingestion, frontal and lateral radiographs of both the upper airway and chest are extremely helpful. Because most of the aspirated foreign bodies are radiolucent, indirect signs of airway obstruction should be sought in chest radiographs including signs of complications of aspirated foreign bodies due to the delay in clinical presentation [17]. Radiographic findings will depend on how obstructive the foreign body is. Some of the common radiographic findings typically include hyperinflation, atelectasis, pneumothorax, or mediastinal shift. In this instance, expiratory views have been proven to aid in the diagnosis [48]. Typically, infants and young children aspirate food items, whereas older children aspirate nonfood items [17]. Some ingested foreign bodies may cause secondary respiratory distress by severe caustic injury to the esophagus and the surrounding tissues, making the diagnosis of aspirated versus ingested foreign body a challenge. This is the case of dishwasher or laundry detergent pods, which infants and toddlers seem to be attracted to [49-52].

The sensitivity and specificity of radiographs in the diagnosis of aspirated foreign body is variable from 35.2% to 45.3% (sensitivity) to 88% to 92.7% (specificity) [15,53], with most studies reporting that there is no correlation between history, physical examination findings, or radiographic findings with the presence of aspirated foreign body at bronchoscopy [15,53,54].

A comparative study by Brown et al [48] evaluated 328 patients with suspected FBA, all of whom had standard chest radiographs. Of these, 192 patients had additional decubitus views, 133 had expiratory views, and 3 had both. When comparing standard views to the additional ones, the study concluded that adding decubitus views increased false positives without improving true positives, providing no additional clinical benefit. In contrast, adding expiratory views increased true positives without raising false positives, but the overall test accuracy remained low, and the

clinical benefit was uncertain. Therefore, if standard radiographs are negative, low-dose CT for further evaluation may be preferable instead of using lateral decubitus or expiratory views if there is still a high clinical suspicion for aspirated foreign body.

Although in clinical practice special views of the chest are often requested, these have shown little added value [48]. Studies have shown that those patients with high suspicion for aspirated foreign bodies received twice the number of imaging studies compared with those who did not. This is attributed to radiographs such as bilateral decubitus views or forced expiratory views, yet studies have shown little added to the diagnosis of aspirated foreign bodies [53,55]. Therefore, in these instances, low-dose CT is likely the preferred method of evaluation.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
O. Radiography chest decubitus view

Bilateral decubitus chest radiographs are typically performed when the expiratory views cannot be obtained, for example, in uncooperative young children. Yet, the literature has shown that there is little added value in performing lateral decubitus views of the chest in the evaluation of ingested or aspirated foreign bodies and are associated with low sensitivity and moderate specificity [48,55]. Therefore, it is recommended that when the clinical suspicion for aspirated foreign body remains high, additional imaging with noncontrast CT or bronchoscopy is promptly performed without delaying patient's management, even when the standard chest radiographs are negative [56-58].

A comparative study by Brown et al [48] evaluated 328 patients with suspected FBA, all of whom had standard chest radiographs. Of these, 192 patients had additional decubitus views, 133 had expiratory views, and 3 had both. When comparing standard views to the additional ones, the study concluded that adding decubitus views increased false positives without improving true positives, providing no additional clinical benefit. In contrast, adding expiratory views increased true positives without raising false positives, but the overall test accuracy remained low, and the clinical benefit was uncertain. Therefore, if standard radiographs are negative, low-dose CT for further evaluation may be preferable instead of using lateral decubitus or expiratory views if there is still a high clinical suspicion for aspirated foreign body.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
P. Radiography neck

A radiograph of the soft tissues of the neck in lateral projection is a valuable imaging tool in the evaluation of swallowed or aspirated foreign bodies, particularly when there is concern about objects lodged in the upper aerodigestive tract. Lateral neck radiograph can provide critical information about the location and nature of the foreign body, as well as their potential complications. It is particularly useful for identifying radiopaque objects such as coins, bones, or metallic items that may or may not be causing obstruction. Additionally, the soft tissue neck radiograph can help detect signs of airway compromise, such as soft tissue swelling or displacement of normal anatomical structures.

Lateral neck radiographs can be useful in the diagnosis of retained fish bone, which will be seen as a linear area of opacity within the prevertebral soft tissues and if not removed promptly, could lead to retropharyngeal soft tissue thickening [17].

In cases in which aspiration is suspected, a neck radiograph may reveal indirect signs such as increased prevertebral soft tissue thickness, which can indicate edema or inflammation secondary

to a foreign body. Furthermore, it can help identify foreign bodies lodged in the upper airway that may not be clearly visible on chest radiographs. By providing a detailed view of both soft tissues and air-filled structures, this imaging modality is essential in early detection and management of foreign body ingestion or aspiration, guiding further steps in the patient's management.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
Q. Radiography neck chest abdomen and pelvis

A radiograph of the soft tissues of the neck in lateral projection is a valuable imaging tool in the evaluation of swallowed or aspirated foreign bodies, particularly when there is concern about objects lodged in the upper aerodigestive tract. Lateral neck radiograph can provide critical information about the location and nature of the foreign body, as well as their potential complications. It is particularly useful for identifying radiopaque objects such as coins, bones, or metallic items that may or may not be causing obstruction. Additionally, the soft tissue neck radiograph can help detect signs of airway compromise, such as soft tissue swelling or displacement of normal anatomical structures.
Lateral neck radiographs can be useful in the diagnosis of retained fish bone, which will be seen as a linear area of opacity within the prevertebral soft tissues and, if not removed promptly, could lead to retropharyngeal soft tissue thickening [17].

In cases in which aspiration is suspected, a neck radiograph may reveal indirect signs such as increased prevertebral soft tissue thickness, which can indicate edema or inflammation secondary to a foreign body. Furthermore, it can help identify foreign bodies lodged in the upper airway that may not be clearly visible on chest radiographs. By providing a detailed view of both soft tissues and air-filled structures, this imaging modality is essential in early detection and management of foreign body ingestion or aspiration, guiding further steps in the patient's management.

In cases of suspected ingested foreign body, chest radiographs will be typically obtained along with neck, abdomen, and pelvis radiographs. Radiographs have a high sensitivity and PPV in the diagnosis of foreign bodies of radiopaque material [21,43,44].

The most commonly ingested foreign body in children are coins (pennies), and they are typically lodged at the superior esophagus. Magnets and button batteries are additional commonly swallowed objects and have been on the rise for the last decade [45]. If a radiopaque foreign body is visualized in the initial frontal radiograph, a lateral radiograph should promptly follow, as the conjunction of frontal and lateral radiographs of the chest can be helpful to differentiate the coins from button batteries and other ingested objects. Button batteries will show a symmetrically circumferential double rim, whereas coins will show a single rim. On the lateral projection, they will be seen in a more linear configuration in which the button batteries will have a bilaminar or step-off appearance. If more than 1 coin is swallowed and stacked together, the lateral view would be beneficial in differentiating the 2 by an asymmetric edge [17,46]. Esophageal coins will typically appear en face on the frontal radiographs. Rarely, coins en face on the lateral projection and linear on the frontal may be in the airway. Studies have demonstrated high sensitivity and accuracy in the differentiation of coin versus button batteries by radiographs [47], and therefore when batteries are diagnosed by radiographs, prompt treatment should follow and no further imaging is recommended.

Patients who ingested radiolucent objects may benefit from different evaluation methods such as low-dose CT or esophagram.

Radiographs of the abdomen are typically obtained in conjunction with radiographs of the neck, chest, and pelvis as the very initial radiologic evaluation for ingested foreign bodies. In most instances, the abdomen and pelvis can be acquired as one anteroposterior view due to the small size of children, which fit into one radiographic field of view. Single abdomen and pelvis radiographs are typically obtained to follow the initial diagnostic radiograph where the foreign body is identified and to evaluate for progression through the GI tract and exclude obstruction.

The ability of radiographs to visualize objects such as plastic, glass, or those organic in nature is limited [21]. In these instances, fluoroscopy and CT without IV contrast will play an important role because they have the ability to visualized these objects [12,37,38,43].

NASPGHAN recommends radiographs as the first imaging modality for suspected foreign body ingestion. Metallic foreign objects such as coins may be treated with expectant management and serial radiographs may be obtained to evaluate for progression through the GI tract [12]. Button batteries; however, are promptly removed to avoid complications.

Lateral abdomen radiographs may be used for evaluation of intestinal obstruction in the setting of ingested foreign body and in the evaluation of free air secondary to bowel perforation. The lateral decubitus view is especially helpful in detecting small amounts of free air, which may not be easily seen on other projections. The cross table lateral view of the abdomen can help identify a more precise location of the foreign body, depending on its anterior or posterior position.

Variant 1: Child. Suspect ingested or aspirated foreign body. Initial imaging.
R. US abdomen

There is no relevant literature to support the use of ultrasound (US) in the initial evaluation of suspected aspirated foreign bodies in children. US can also play a valuable role in the evaluation of ingested foreign bodies when other modalities cannot routinely provide needed diagnostic information. These include ingested water bead evaluation and the emerging use of determining intraluminal versus extraluminal location of nonmobile magnets.

Water beads, also known as superabsorbent polymer balls, pose a significant risk if ingested because they expand when in contact with fluids, potentially causing bowel obstruction. US is useful in identifying distended bowel loops, localized dilatation, or signs of obstruction caused by the beads. Moreover, it can be used to monitor for complications such as intussusception, perforation, or inflammation. Although US may not visualize the beads themselves directly, its usefulness lies in assessing the secondary effects of ingestion, such as fluid collections or bowel thickening. In combination with clinical judgment and other imaging modalities, US can aid in the timely diagnosis and management of swallowed water beads, reducing the need for more invasive procedures such as CT. An additional emerging application of abdominal US is in the setting of ingested magnets, which may be helpful to determine intraluminal versus extraluminal location [59]. US is most commonly considered in these focused situations following initial radiographs.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.

If the suspected swallowed foreign body is not radiographically visible, additional imaging such as low-dose CT chest without IV contrast or single-contrast esophagram can help elucidate the object. The goal of imaging is to identify the presence and location of a swallowed foreign object

in children. Imaging information aids clinicians to determine the next steps in the patient's management related to removal of the object or follow-up imaging until self-eliminated. The information gained by the images helps the patients by preventing potential complications with long-term side effects of swallowed or inhaled foreign bodies.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.
A. CT abdomen and pelvis with IV contrast

There is no relevant literature to support the use of CT abdomen and pelvis with IV contrast as the next imaging evaluation of suspected ingested foreign bodies in children.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.
B. CT abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast as the next imaging evaluation of suspected ingested foreign bodies in children.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.
C. CT abdomen and pelvis without IV contrast

There is no relevant literature to support the use of CT abdomen and pelvis without IV contrast as the next imaging evaluation of suspected ingested foreign bodies in children.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.
D. CT chest abdomen pelvis with IV contrast

There is no relevant literature to support the use of CT chest, abdomen, and pelvis with IV contrast as the next imaging evaluation of suspected ingested foreign bodies in children.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.
E. CT chest abdomen pelvis without and with IV contrast

There is no relevant literature to support the use of CT chest, abdomen, and pelvis without and with IV contrast as the next imaging evaluation of suspected ingested foreign bodies in children.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.
F. CT chest abdomen pelvis without IV contrast

There is no relevant literature to support the use of CT chest, abdomen, and pelvis without IV contrast as the next imaging evaluation of suspected ingested foreign bodies in children.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.
G. CT chest with IV contrast

There is no relevant literature to support the use of CT chest with IV contrast as the next imaging evaluation of suspected ingested foreign bodies in children.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.
H. CT chest without and with IV contrast

There is no relevant literature to support the use of CT chest without and with IV contrast as the next imaging evaluation of suspected ingested foreign bodies in children.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.

I. CT chest without IV contrast

The imaging evaluation of children presenting with symptoms concerning for ingested esophageal foreign bodies often is performed using radiographs. However, some radiolucent foreign bodies may not be detected by this modality, requiring further evaluation with a fluoroscopic esophagram. In the adult population, CT has been increasingly used in place of fluoroscopy [32-34] or radiographs with a reported sensitivity of 100%, specificity of 92.6%, negative predictive value of 100%, and PPV of 97.9% [35].

Low-dose CT offers many advantages over esophagram including consistent, nonoperator-dependent image acquisition; rapid performance; not requiring IV or oral contrast; reducing the risk of aspiration with oral contrast; and requiring less patient cooperation [21].

Therefore, CT has emerged as a very useful tool in the evaluation of ingested foreign bodies in the pediatric population and at multiple institutions has been implemented as the first-line imaging modality for the diagnosis of radiolucent ingested foreign bodies [4,21].

The use of oral contrast in low-dose chest CT has primarily been studied in adults, particularly in cases of suspected esophageal perforation, rather than for initial imaging evaluations due to the risk of potential aspiration [36]. Although oral contrast has the risk of potential aspiration, some adult studies have reported on the improved value of CT administering oral contrast [36,40]. Currently, there are no data supporting the use of oral contrast in CT imaging for this purpose in the pediatric population.

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.

J. Fluoroscopy single contrast esophagram

Esophagram has been the most prevalent modality used in the evaluation of pediatric esophageal food impaction [21,37,38] and the second line of evaluation when the initial radiographs failed to demonstrate an abnormality and the clinical concern for food impaction is high [11]. Yet, authors have advocated that fluoroscopy is not required if the clinical presentation is typical and should not delay endoscopy with removal of impacted bolus [11].

Esophagrams do carry their own inherent risks. The oral contrast poses a risk for aspiration and may interfere with subsequent procedures such as endoscopy or foreign body removal [39]. Although oral contrast has the risk of potential aspiration, some adult studies have reported on the improved value of CT administering oral contrast [36,40]. Fluoroscopy may fail to diagnose other causes of the patient's symptoms [36,39,41,42].

Increasingly, the literature supports the use of noncontrast chest CT for the diagnosis of ingested foreign bodies in adult and pediatric patients; however, there are no current guidelines for the pediatric population that exist to date. Despite this, some sites have adopted CT and have reported that CT has become the first line of evaluation replacing esophagrams [4,21].

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging

study.

K. Fluoroscopy upper GI series

A complete UGI fluoroscopy series is rarely performed and has been mostly replaced by a fluoroscopy esophagram. If the concern is for an ingested foreign body below the level of the esophagus and proximal to the ligament of Treitz, then a complete UGI series may be warranted. However, in these instances, endoscopy with removal may take priority.

Esophagram has been the most prevalent modality used in the evaluation of pediatric esophageal food impaction [21,37,38] and the second line of evaluation when the initial radiographs failed to demonstrate an abnormality and the clinical concern for food impaction is high [11]. Yet, authors have advocated that fluoroscopy is not required if the clinical presentation is typical and should not delay endoscopy with removal of impacted bolus [11].

Sudden onset of dysphagia after food ingestion is the typical presentation symptom of food impaction. In this situation, the food impaction prevents other foods or liquids from passing through and needs to be emergently removed. This tends to affect children beyond the infancy period, however, the prevalence in the pediatric population has not been well established in the literature [10]. In adults, the incidence has been reported to affect 13 per 100,000 adults [11,12]. The reasons for food impaction have been studied with eosinophilic esophagitis found to be the most common, followed by prior esophageal atresia repair and Nissen fundoplication [10,11,14].

Behavioral factors need to also be considered as an etiology of food impaction, likely secondary to incomplete chewing and eating quickly. Although fluoroscopy is not required to reach the proper diagnosis, it is frequently requested by emergency department or GI providers and, in most clinical practices, it precedes endoscopic evaluation and removal [10].

Esophagrams carry their own inherited risks. The oral contrast poses a risk for aspiration and may interfere with subsequent procedures such as endoscopy or foreign body removal [39]. Although oral contrast has the risk of potential aspiration, some adult studies have reported on the improved value of CT administering oral contrast [36,40]. Fluoroscopy may fail to diagnose other causes of the patient's symptoms [36,39,41,42].

Variant 2: Child. Suspect ingested foreign body. Initial radiographs negative. Next imaging study.

L. US abdomen

US is a valuable tool for evaluating ingested water beads in pediatric patients. Although the frequency of water bead ingestion is lower than that of coins or batteries, it can result in severe complications, such as bowel obstruction. An analysis of the National Electronic Injury Surveillance System over a 15-year period revealed that only 1.7% of pediatric emergency department visits were related to water bead ingestion. US is particularly useful in these cases [59,60].

Water beads, also known as superabsorbent polymer balls, pose a significant risk when ingested, as they can expand up to 400 times their original size when exposed to water, potentially causing bowel obstruction [61]. Zamora et al [62] demonstrated that these beads grow most rapidly during the first 12 hours after immersion. Water beads are commonly found in botanical arrangements and a variety of toys and have recently been marketed as learning aids for children with autism [61].

Symptoms of ingestion can be nonspecific, and initial abdominal radiographs may show a range of findings, from a nonobstructive bowel gas pattern with no radiopaque foreign body, to distended bowel loops, localized dilation, or obstruction. Symptoms of water bead ingestion have been reported to occur anywhere from 6 hours to several days after ingestion [61,63]. If ingestion is suspected or witnessed, US is an ideal method for detecting water beads in the stomach or small bowel. However, when ingestion is not witnessed, diagnosis may be delayed until secondary complications arise. Proper identification of ingested water beads can be challenging and may only occur during endoscopy or surgical exploration [64]. It is important to note that US can underestimate the number of beads present in the abdomen, as some may be obscured by bowel gas artifact. If there is high clinical suspicion and at least one water bead is identified in the GI tract by US, surgical and GI consultation should not be delayed.

An additional emerging application of abdominal US is in the setting of ingested magnets, which may be helpful to determine intraluminal versus extraluminal location [59].

Variant 3: Child. Suspect aspirated foreign body. Initial radiographs negative. Next imaging study.

In this scenario, the diagnosis of an aspirated foreign body may or may not have been established. If the object is not visible on the initial chest radiographs, additional imaging can be useful in detecting the foreign body or identifying indirect signs of its presence.

The primary goal of imaging is to determine whether a child has inhaled a foreign object and, if so, to locate it. This information guides clinicians in deciding the next steps, whether it involves removing the object or monitoring it with follow-up imaging until it is naturally eliminated. Imaging also helps prevent potential complications that can arise from retained or inhaled foreign bodies, which could lead to long-term side effects.

Variant 3: Child. Suspect aspirated foreign body. Initial radiographs negative. Next imaging study.
A. CT chest with IV contrast

There is no relevant literature to support the use of CT chest with IV contrast as the next imaging evaluation of suspected aspirated foreign bodies in children.

Variant 3: Child. Suspect aspirated foreign body. Initial radiographs negative. Next imaging study.
B. CT chest without and with IV contrast

There is no relevant literature to support the use of CT chest without and with IV contrast as the next imaging evaluation of suspected aspirated foreign bodies in children.

Variant 3: Child. Suspect aspirated foreign body. Initial radiographs negative. Next imaging study.
C. CT chest without IV contrast

When children present to the emergency department with a history of choking, coughing, or a witnessed aspiration event, the concern for FBA is high. This is also true for nonverbal noncommunicative patients for whom the signs and symptoms raise the concern for FBA. Although bronchoscopy is considered the reference standard for diagnosing, it is associated with a high false-negative rate.

In the past decade, CT has emerged as a valuable initial modality to evaluate for foreign bodies in the tracheobronchial tree, potentially reducing the need for bronchoscopy [18,26]. New low-dose CT protocols now provide detailed imaging of the entire tracheobronchial tree, pulmonary parenchyma, and pharyngeal region. In some institutions, clinical diagnostic pathways have been created in which a limited z-axis (from the larynx to the proximal segmental bronchi of the lower lungs) low-dose CT is initially obtained in the workup of this patient population [4].

The ability to rapidly acquire pediatric optimized noncontrast CT, coupled with the high diagnostic performance, has made CT a very useful tool for the initial evaluation of patients with suspected FBA [19,27-29]. The images can be reformatted in multiple planes, using minimum intensity projection, and postprocessed to create "3-D-virtual bronchoscopy," further reducing the need for unnecessary bronchoscopy.

A recent meta-analysis of 16 studies involving 2,056 pediatric patients found that CT had a sensitivity of 98.8% and a specificity of 96.6% for diagnosing FBA [23]. When 3-D virtual bronchoscopy was added, the sensitivity and specificity increased to 99.4% and 99%, respectively. The same meta-analysis reported a low CT false-positive rate (1.5%) and false-negative rate (0.5%). Another meta-analysis involving 4,178 patients reported a sensitivity and specificity of 99% and 92%, respectively, with a false-negative rate of 1.8% [29]. Similarly, other smaller but more recent studies have reported similar high sensitivity (100%) and specificity (85.7%) in the CT detection of FBA.

The usefulness of 3-D CT reconstructions in diagnosing FBA has also been evaluated [16,30,31]. A study by Yang et al [16], reported a diagnostic accuracy with a sensitivity of 99.83% and a specificity of 99.89%, with the most commonly aspirated foreign bodies being peanuts and sunflower seeds. Along with others [18,30], they concluded that acutely ill patients or those with clear clinical evidence of FBA should be taken directly to the operating room rather than delaying care by obtaining CT or other imaging.

Pediatric patients have unique needs that require specially tailored CT protocols distinct from those used for adults. It is crucial for institutions to follow the ALARA principle and adhere to ACR guidelines to minimize radiation exposure [22]. The development of newer low-dose chest CT protocols is a prime example of how pediatric imaging can be optimized for safety without compromising diagnostic quality.
Based on the literature, low-dose CT of the chest should be considered for evaluating suspected pediatric FBA in cases even when there is no respiratory distress and a prior chest radiograph is unrevealing.

Variant 3: Child. Suspect aspirated foreign body. Initial radiographs negative. Next imaging study.
D. Fluoroscopy single contrast esophagram

There is no relevant literature to support the use of fluoroscopy single contrast esophagram as the next imaging evaluation of suspected aspirated foreign bodies in children.

Variant 3: Child. Suspect aspirated foreign body. Initial radiographs negative. Next imaging study.
E. Fluoroscopy upper GI series

There is no relevant literature to support the use of fluoroscopy UGI series as the next imaging evaluation of suspected aspirated foreign bodies in children.

Variant 3: Child. Suspect aspirated foreign body. Initial radiographs negative. Next imaging study.

F. Radiography chest decubitus view

Bilateral decubitus chest radiographs are typically performed when the expiratory views cannot be obtained, for example, in young children unable to cooperate. Yet, the literature has shown that there is little value in performing lateral decubitus views of the chest in the workup of ingested or aspirated foreign bodies and that they are associated with low sensitivity and moderate specificity [48,55]. Therefore, it is recommended that when the clinical suspicion for aspirated foreign body remains high, additional imaging with noncontrast CT or bronchoscopy is promptly performed without delaying patient's management, even when the standard chest radiographs are negative [56-58].

A comparative study by Brown et al [48] evaluated 328 patients with suspected FBA, all of whom had standard chest radiographs. Of these, 192 patients had additional decubitus views, 133 had expiratory views, and 3 had both. When comparing standard views to the additional ones, the study concluded that adding decubitus views increased false positives without improving true positives, providing no additional clinical benefit. In contrast, adding expiratory views increased true positives without raising false positives, but the overall test accuracy remained low, and the clinical benefit was uncertain. Therefore, if standard radiographs are negative, follow-up with low-dose CT for further evaluation instead of using lateral decubitus or expiratory views if clinical suspicion remains high.

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variant 1:** In the initial evaluation of suspected ingested or aspirated foreign bodies in children, appropriate imaging includes radiographs of the neck, chest, abdomen, and pelvis, which are often complementary. Low-dose noncontrast chest CT may also be appropriate, even for initial imaging in selected cases, when there is concern for radiolucent foreign bodies.
- **Variant 2:** In cases when a swallowed foreign body is suspected but not seen on initial radiographs, additional imaging with low-dose noncontrast chest CT is usually appropriate. CT has emerged as a valuable tool for detecting radiolucent objects because of its high diagnostic accuracy. Although fluoroscopic esophogram may be appropriate, it may increase aspiration risk from oral contrast. Abdominal US is particularly useful for evaluating ingested water beads.
- **Variant 3:** In cases when a child is suspected of having aspirated a foreign body, but initial chest radiographs are negative, further imaging is often necessary to confirm the diagnosis and guide treatment. Among the imaging options, low-dose noncontrast CT of the chest has emerged as a highly effective tool, offering detailed visualization of the airways and surrounding structures. In comparison, lateral decubitus chest radiographs have shown limited diagnostic value and may increase false positives without improving outcomes. Therefore, when clinical suspicion remains high for aspiration despite negative radiographs,

low-dose chest CT is usually appropriate.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose

quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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