

ACR Appropriateness Criteria[®]

Epigastric Pain

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Abstract

Many different pathologies can present with epigastric pain, and the overlap of the symptoms of these varying entities can make diagnosis difficult clinically. This document focuses on scenarios including esophageal and gastroduodenal perforations, those occurring after post reflux surgeries and procedures, gastroesophageal reflux disease (GERD), esophagitis, gastritis, peptic ulcer disease, and hiatal hernias. Also included is recurrent GERD and hiatal hernia post reflux procedures and surgeries.

The American College of Radiology Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed annually by a multidisciplinary expert panel. The guideline development and revision process support the systematic analysis of the medical literature from peer reviewed journals. Established methodology principles such as Grading of Recommendations Assessment, Development, and Evaluation or GRADE are adapted to evaluate the evidence. The RAND/UCLA Appropriateness Method User Manual provides the methodology to determine the appropriateness of imaging and treatment procedures for specific

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Disclaimer: 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.

clinical scenarios. In those instances where peer reviewed literature is lacking or equivocal, experts may be the primary evidentiary source available to formulate a recommendation.

Key Words: Appropriateness Criteria, Appropriate Use Criteria, AUC, epigastric pain, gastroesophageal reflux disease, hiatal hernia, postsurgical antireflux surgery, upper gastrointestinal inflammation, upper gastrointestinal perforation

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ACR Appropriateness Criteria® Epigastric Pain. [Variants 1 to 2](#) and [Tables 1 and 2](#)

Variant 1. Adult. Epigastric pain as acute or new symptoms. Suspected upper gastrointestinal tract source. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	⦿⦿⦿
CT abdomen with IV contrast	Usually Appropriate	⦿⦿⦿
CT chest without and with IV contrast	Usually Appropriate	⦿⦿⦿
CT chest and abdomen with IV contrast	Usually Appropriate	⦿⦿⦿⦿
Fluoroscopy single-contrast esophagram	May Be Appropriate	⦿⦿⦿
Fluoroscopy upper GI series	May Be Appropriate	⦿⦿⦿
Radiography chest abdomen pelvis	May Be Appropriate	⦿⦿⦿
CT abdomen without IV contrast	May Be Appropriate	⦿⦿⦿
CT chest with IV contrast	May Be Appropriate (Disagreement)	⦿⦿⦿
CT chest without IV contrast	May Be Appropriate (Disagreement)	⦿⦿⦿
CT chest and abdomen without and with IV contrast	May Be Appropriate (Disagreement)	⦿⦿⦿⦿
CT chest and abdomen without IV contrast	May Be Appropriate	⦿⦿⦿⦿
Fluoroscopy biphasic esophagram	Usually Not Appropriate	⦿⦿⦿
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⦿⦿⦿
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT abdomen without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿

Variant 2. Adult. Epigastric pain with known or suspected chronic symptoms of upper gastrointestinal tract inflammatory or infectious etiology. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Fluoroscopy biphasic esophagram	Usually Appropriate	⦿⦿⦿
Fluoroscopy upper GI series	Usually Appropriate	⦿⦿⦿
Fluoroscopy single-contrast esophagram	May Be Appropriate	⦿⦿⦿
CT abdomen and pelvis with IV contrast	May Be Appropriate (Disagreement)	⦿⦿⦿
CT abdomen with IV contrast	May Be Appropriate	⦿⦿⦿
CT abdomen without IV contrast	May Be Appropriate	⦿⦿⦿
CT chest and abdomen with IV contrast	May Be 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 chest without IV contrast	Usually Not Appropriate	⦿⦿⦿
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT abdomen without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT chest and abdomen without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT chest and abdomen without IV contrast	Usually Not Appropriate	⦿⦿⦿⦿

Table 1. 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.

Table 2. Relative radiation level designations

RRL	Adult Effective Dose Estimate Range (mSv)	Pediatric Effective Dose Estimate Range (mSv)
○	0	0
⊕	<0.1	<0.03
⊕⊕	0.1-1	0.03-0.3
⊕⊕⊕	1-10	0.3-3
⊕⊕⊕⊕	10-30	3-10
⊕⊕⊕⊕⊕	30-100	10-30

Note: Relative radiation level (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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “varies.”

SUMMARY OF LITERATURE REVIEW

Introduction/Background

Many different diseases can present with epigastric pain, including myocardial infarction, pancreatitis, acute aortic syndromes, perforation of the esophagus, stomach or duodenum, gastroesophageal reflux disease (GERD), prior and post antireflux or gastric bypass surgeries, esophagitis, peptic ulcer disease (PUD), gastritis, duodenal ulcer disease, gastric cancer, and hiatal hernia. The symptomatology of these diseases may also overlap, which makes diagnosis difficult; thus, the patient's clinical history and risk factors are important to narrow the differential diagnosis further.

This document focuses on the scenarios in which epigastric pain is accompanied by symptoms such as heartburn, regurgitation, dysphagia, nausea, and vomiting. The situations in which epigastric pain is accompanied by relevant risk factors and symptoms, such as shortness of breath with exertion, pain radiating to the back, and other causes, suggesting the possibility of myocardial infarction, pancreatitis, or acute aortic syndromes are not the focus of this document and are discussed in other ACR Appropriateness Criteria documents (see the ACR Appropriateness Criteria® topics on “Suspected Acute Aortic Syndrome” [1], “Chest Pain-Possible Acute Coronary Syndrome” [2], “Chronic Chest Pain-High Probability of Coronary Artery Disease” [3], “Nontraumatic Aortic Disease” [4], and “Acute Pancreatitis” [5] for further guidance). In addition, esophageal and gastric cancer are not the focus of this document and are discussed in other ACR Appropriateness Criteria documents (see the ACR Appropriateness Criteria® topics on “Staging and Follow-Up of Esophageal Cancer” [6] and “Staging and Follow-Up of Gastric Cancer” for further guidance) [7]. Gastrointestinal (GI) bleeding will also not be covered in this document (see the ACR Appropriateness Criteria® topics on “Radiologic Management of Lower Gastrointestinal Tract Bleeding” [8] and “Nonvariceal Upper Gastrointestinal Bleeding” [9] for further guidance).

Special Imaging Considerations

Positive, neutral, or negative oral contrast can be used in CT examinations and is not considered a separate procedure in this document. The use of a specific type of oral contrast will be discussed within the different variants and sections as appropriate. There is a small risk of contrast reaction due to 1% to 2% of ingested iodinated contrast material being absorbed [10].

Throughout this narrative for Variant 1, the “Chest CT” procedures refer to chest CT examinations performed using the CT esophagram protocol, which varies from institution to institution. For Variant 2, the “Chest CT” procedures refer to chest CT examinations as normally performed.

The pelvis portion of the examination may not be necessary in the evaluation of gastric and duodenal etiologies. Endoscopy can play a role in the diagnosis, evaluation, and management of the entities discussed in this document. However, given that endoscopy is not an imaging examination, endoscopy will not be discussed as a free standing procedure under the different variants covered in this document.

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: Adult. Epigastric pain as acute or new symptoms. Suspected upper gastrointestinal tract source. Initial imaging

In this variant, esophageal and gastroduodenal perforations including those occurring after post antireflux surgeries and procedures are discussed, which are life-threatening emergencies. This variant also encompasses other acute complications, which can occur after laparoscopic antireflux surgery such as intrathoracic migration, paraesophageal herniation, and perforation [11]. The goal of imaging is the accurate, timely diagnosis or detection, and characterization of esophageal or gastroduodenal perforation, and other postsurgical or postprocedural complications related to antireflux surgeries. This imaging information improves patient outcome by determining whether there is gastroesophageal or peptic ulcer perforation or postsurgical or postprocedural complications, thereby guiding appropriate management. For postoperative imaging evaluation in gastric bypass surgery, please see the ACR Appropriateness Criteria® topic on “Preoperative and Postoperative Imaging for Bariatric Procedures” [12].

The mortality rate of esophageal perforation is 10% to 15% [13], and a delay in treatment that is >13 hours can increase the mortality rate by 3-fold [14]. The mortality rate for gastroduodenal perforation related to PUD is 1.3% to 20%, with a 30-day mortality rate of 20%, and a 90-day mortality rate up to 30% [15]. Common causes of esophageal perforation include acute chest trauma, violent retching, and iatrogenic complications [16], and less commonly, esophageal cancer, ulcer, foreign body, and acids/chemical ingestion. Common causes of gastroduodenal perforation include PUD, trauma, malignancy, and iatrogenic injuries [11]. Patients may have nonspecific signs and symptoms clinically, and, therefore, imaging is important in the accurate and timely diagnosis of these pathologies.

According to the Society of American Gastrointestinal and Endoscopic Surgeons and the American College of Gastroenterology, surgical treatment of GERD can be sought in patients with a desire to discontinue medical therapy, who are non-compliant with medical therapy, and when medical treatment does not control symptoms. Common surgical procedures include hiatal hernia surgery and fundoplication to help increase the resting pressure of the lower esophageal sphincter [17]. There are also newer procedures that aim to improve GERD symptoms including magnetic sphincter augmentation, Stretta procedure, and transoral incisionless fundoplication [18]. As stated above, complications related to these procedures include gastric or esophageal perforation, intrathoracic migration, paraesophageal herniation, and perforation.

Of note, throughout Variant 1, the “Chest CT” procedures refer to chest CT examinations performed using the CT esophagram protocol, which varies from institution to institution.

CT Abdomen and Pelvis With IV Contrast. CT abdomen with intravenous (IV) contrast can be useful in the evaluation for gastroduodenal perforation. CT is more sensitive in the detection of free air in the abdomen compared with plain radiography [19]. In addition, when compared to plain radiography, CT can correctly identify the cause and location of free air with a sensitivity of 85.5% [19]. PUD is the main cause of nontraumatic gastroduodenal perforation [20]. In a study by Lee et al [20] a wall defect and/or ulcer showed a positive likelihood ratio for gastroduodenal perforation of 36.83 and wall thickening showed a positive likelihood ratio of 10.52. Combined, these two features showed 95% sensitivity and 93% specificity for localization of a site of perforation [20]. If oral contrast is administered, extraluminal contrast may be seen at the site of perforation [21]. If bowel perforation is suspected, then water-soluble positive oral contrast is preferred over barium due to reduced risk of severe inflammatory response if leakage occurs [22]. In patients with aspiration risk, low-osmolality and iso-osmolar water-soluble agents pose a much lower risk for life-threatening pulmonary edema due to aspiration than high-osmolar contrast media [23].

CT pelvis may not be needed when the entity suspected is only of the upper GI tract. However, it can be useful to exclude other sites of GI tract perforation and to differentiate from other possible pathologies that present with epigastric pain.

CT abdomen with IV contrast is useful in the evaluation of symptoms after antireflux surgeries as it can identify complications such as perforation, abscess, and in the setting of fundoplication, the location and integrity of the wrap, stomach slippage above the diaphragm, and development or recurrence of a hiatal hernia, and help evaluate for the need for redo surgery [24,25]. Several studies used positive oral contrast [25,26]; however, there are no data in the literature that specifically compares the use of positive oral contrast versus no positive oral contrast use. The pelvis portion of the examination may not be necessary.

CT Abdomen With IV Contrast. A CT abdomen with IV contrast can be useful in the setting of suspected gastroduodenal perforation. CT is more sensitive in the detection of free air in the abdomen compared with plain radiography [19]. In addition, when compared to plain radiography, CT can correctly identify the cause and location of free air with a sensitivity of 85.5% [19]. PUD

is the main cause of nontraumatic gastroduodenal perforation [20]. In a study by Lee et al [20] a wall defect and/or ulcer showed a positive likelihood ratio for gastroduodenal perforation of 36.83 and wall thickening showed a positive likelihood ratio of 10.52. Combined, these two features showed 95% sensitivity and 93% specificity for localization of a site of perforation [20]. If oral contrast is administered, extraluminal contrast may be seen at the site of perforation [21].

After antireflux surgeries, CT abdomen with IV contrast is useful in the evaluation of symptoms as it can identify complications such as perforation, abscess, and in the setting of fundoplication, the location and integrity of the wrap, stomach slippage above the diaphragm, and development or recurrence of a hiatal hernia, and help evaluate for the need for redo surgery [24,25]. Several studies used positive oral contrast [25,26]; however, there are no data in the literature that specifically compares the use of positive oral contrast versus no positive oral contrast use.

CT Chest Without and With IV Contrast. The “Chest CT” portion of this procedure refers to chest CT performed using the CT esophagram protocol, which varies from institution to institution.

CT esophagram without and with IV contrast is used in the setting of suspected esophageal perforation. The precontrast phase can help identify any radiopaque material prior to the administration of positive enteric contrast [16]. There can be different protocols for CT esophagram depending on the institution; however, it usually involves a precontrast scan and a post-oral contrast scan [16]. If bowel perforation is suspected, then water-soluble positive oral contrast is preferred over barium due to the reduced risk of severe inflammatory response if leakage occurs [22]. In patients with aspiration risk, low-osmolality and iso-osmolar water-soluble agents pose a much lower risk for life-threatening pulmonary edema due to aspiration than high-osmolar contrast media [23]. If IV contrast is needed to differentiate between various pathologies, which can present with atypical chest pain, this second scan can be performed with IV contrast. In one study, CT esophagram was found to have a sensitivity of 100% and a specificity of 79.8%, compared with fluoroscopic examination with a sensitivity of 77.8% and a specificity of 98.9% [27]. Another study also demonstrated better CT/CT esophagram sensitivity in the diagnosis of esophageal perforation when compared to fluoroscopic esophagram, with a sensitivity of 79% to 89% and 46%, respectively [28].

CT Chest and Abdomen With IV Contrast. The “Chest CT” portion of this procedure refers to chest CT performed using the CT esophagram protocol, which varies from institution to institution.

CT esophagram is a useful diagnostic tool in patients with esophageal perforation and presents with atypical chest pain [16]. There are different protocols for CT esophagram depending on the institution; however, it usually involves a precontrast scan and a post-oral contrast scan [16]. If IV contrast is needed to differentiate between various pathologies, which can present with atypical chest pain, this second scan can be performed with IV contrast. In one study, CT esophagram was found to have a sensitivity of 100% and a specificity of 79.8%, compared with fluoroscopic examination with a sensitivity of 77.8% and a specificity of 98.9% [27]. Another study also demonstrated better CT/CT esophagram sensitivity in the diagnosis of esophageal perforation when compared to fluoroscopic esophagram, with a sensitivity of 79% to 89% and 46%, respectively [28].

CT abdomen with IV contrast can be useful in the evaluation for gastroduodenal perforation. CT is more sensitive in the detection of free air in the abdomen compared with plain radiography [19]. In addition, when compared to plain radiography, CT can correctly identify the cause and location of free air with a sensitivity of 85.5% [19]. PUD is the main cause of nontraumatic gastroduodenal perforation [20]. In a study by Lee et al [20] a wall defect and/or ulcer showed a positive likelihood ratio for gastroduodenal perforation of 36.83 and wall thickening showed a positive likelihood ratio of 10.52. Combined, these two features showed 95% sensitivity and 93% specificity for localization of a site of perforation [20]. If oral contrast is administered, extraluminal contrast may be seen at the site of perforation [21]. If bowel perforation is suspected, then water-soluble positive oral contrast is preferred over barium due to reduced risk of severe inflammatory response if leakage occurs [22]. In patients with aspiration risk, low-osmolality and iso-osmolar water-soluble agents pose a much lower risk for life-threatening pulmonary edema due to aspiration than high-osmolar contrast media [23].

After antireflux surgeries, CT esophagram may be performed if there is concern for esophageal perforation. CT abdomen with IV contrast is useful in the evaluation of symptoms as it can identify complications such as perforation, abscess, and in the setting of fundoplication, the location and integrity of the wrap, stomach slippage above the diaphragm, and development or recurrence of a hiatal hernia, and help evaluate for the need for redo surgery [24,25]. Several studies used positive oral contrast [25,26]; however, there are no data in the literature that specifically compares the use of positive oral contrast versus no positive oral contrast use.

Fluoroscopy Single-Contrast Esophagram. Traditionally, fluoroscopic single-contrast esophagram and upper GI series

with water-soluble contrast are performed for suspected esophageal and/or gastroduodenal perforation, respectively [16,29]. However, 10% to 12% of esophageal perforations may be missed on a fluoroscopic examination with barium, and 22% to 50% of cases may be missed on a fluoroscopic examination with water-soluble contrast alone [27]. In one study, CT esophagram sensitivity was found to be 100% with a specificity of 79.8%, compared with fluoroscopic examination with a sensitivity of 77.8% and a specificity of 98.9% [27]. Another study also demonstrated better CT/CT esophagram sensitivity in the diagnosis of esophageal perforation when compared to fluoroscopic esophagram, with a sensitivity of 79% to 89% and 46%, respectively [28].

After antireflux surgery, there is no consensus for the routine performance of postoperative esophagram to assess for postoperative leak. Thus, these studies are performed per institutional/surgeon preference, usually between day 1 and day 3 after surgery [11].

Fluoroscopy Upper GI Series. Traditionally, fluoroscopic single-contrast esophagram and upper GI series with water-soluble contrast are performed for suspected esophageal and/or gastroduodenal perforation, respectively [16,29,30]. However, 10% to 12% of esophageal perforations may be missed on a fluoroscopic examination with barium, and 22% to 50% of cases may be missed on a fluoroscopic examination with water-soluble contrast alone [27]. In one study, CT esophagram sensitivity was found to be 100% with a specificity of 79.8%, compared with fluoroscopic examination with a sensitivity of 77.8% and a specificity of 98.9% [27]. Another study also demonstrated better CT/CT esophagram sensitivity in the diagnosis of esophageal perforation when compared to fluoroscopic esophagram, with a sensitivity of 79% to 89% and 46%, respectively [28]. Even though the data demonstrate that CT esophagram performs better than fluoroscopic examinations, fluoroscopic examinations are still useful for this variant.

After procedural antireflux treatment, fluoroscopy upper GI series may be performed to evaluate the fundoplication wrap integrity and location, assess for leak, esophageal emptying impairment, stomach slippage above the diaphragm, and development or recurrence of a hiatal hernia [17].

Radiography Chest Abdomen Pelvis. Radiography is usually the first-line modality in suspected gastroduodenal perforation to detect free air in the abdomen [11]. However, it is our expert opinion that regardless of whether free air is seen or not on radiography, in clinical practice, a CT will always be obtained. Thus, our expert opinion is to forgo this procedure. On upright and left decubitus abdominal radiographs, it has been cited that even 1 mL of free air can be detected [31], and the high

miss rate of free air on radiography has been attributed to technical factors such as poor image quality without inclusion of the upper abdomen/lower chest rather than the limitations of radiography itself [32].

Different positioning for radiography can also impact the sensitivity for detection of free air in the abdomen. The diagnostic accuracy for free air in a left decubitus radiograph is 96%, 85% for a chest radiograph, 60% for an upright abdominal radiograph, and 56% for a supine abdominal radiograph [33].

CT Abdomen Without IV Contrast. There is no relevant literature to support the use of CT abdomen without IV contrast for this clinical scenario, but this procedure may be useful in certain circumstances, such as perforation, per expert opinion.

In the post antireflux surgery or procedure setting, a CT abdomen examination without IV contrast can be useful with accurate depiction of anatomy [26].

CT Chest With IV Contrast. The “Chest CT” portion of this procedure refers to chest CT performed using the CT esophagram protocol, which varies from institution to institution.

CT esophagram is a useful diagnostic tool in patients with esophageal perforation and presents with atypical chest pain [16]. There can be different protocols for CT esophagram depending on the institution; however, it usually involves a precontrast scan and a post-oral contrast scan [16]. If bowel perforation is suspected, then water-soluble positive oral contrast is preferred over barium due to the reduced risk of severe inflammatory response if leakage occurs [22]. In patients with aspiration risk, low-osmolality and iso-osmolar water-soluble agents pose a much lower risk for life-threatening pulmonary edema due to aspiration than high-osmolar contrast media [23]. If IV contrast is needed to differentiate between various pathologies, which can present with atypical chest pain, this second scan can be performed with IV contrast. In one study, CT esophagram was found to have a sensitivity of 100% and a specificity of 79.8%, compared with fluoroscopic examination with a sensitivity of 77.8% and a specificity of 98.9% [27]. Another study also demonstrated better CT/CT esophagram sensitivity in the diagnosis of esophageal perforation when compared to fluoroscopic esophagram, with a sensitivity of 79% to 89% and 46%, respectively [28].

CT Chest Without IV Contrast. The “Chest CT” portion of this procedure refers to chest CT performed using the CT esophagram protocol, which varies from institution to institution.

CT esophagram without IV contrast has been found to be 100% sensitive in the detection of esophageal

perforation with a 100% negative predictive value [34]. If bowel perforation is suspected, then water-soluble positive oral contrast is preferred over barium due to the reduced risk of severe inflammatory response if leakage occurs [22]. In patients with aspiration risk, low-osmolality and iso-osmolar water-soluble agents pose a much lower risk for life-threatening pulmonary edema due to aspiration than high-osmolar contrast media [23]. There is a small risk of contrast reaction due to 1% to 2% of ingested iodinated contrast material being absorbed [10].

CT Chest and Abdomen Without and With IV Contrast. The “Chest CT” portion of this procedure refers to a chest CT performed using the CT esophagram protocol, which varies from institution to institution.

There is no relevant literature to support the addition of CT abdomen without and with IV contrast for this clinical scenario.

CT Chest and Abdomen Without IV Contrast. The “Chest CT” portion of this procedure refers to chest CT performed using the CT esophagram protocol, which varies from institution to institution.

CT chest/CT esophagram without IV contrast or oral contrast has been found to be 100% sensitive in the detection of esophageal perforation with a 100% negative predictive value [34].

There is no relevant literature with specific data for CT abdomen examination without IV contrast for this clinical scenario. If bowel perforation is suspected, then water-soluble positive oral contrast is preferred over barium due to the reduced risk of severe inflammatory response if leakage occurs [22]. In patients with aspiration risk, low-osmolality and iso-osmolar water-soluble agents pose a much lower risk for life-threatening pulmonary edema due to aspiration than high-osmolar contrast media [23]. There is a small risk of contrast reaction due to 1% to 2% of ingested iodinated contrast material being absorbed [10].

Fluoroscopy Biphasic Esophagram. There is no relevant literature to support the use of fluoroscopy biphasic esophagram for this clinical scenario.

A biphasic fluoroscopic evaluation of the esophagus includes single- and double-contrast techniques, including an upright double-contrast phase where the two contrasts are a high-density barium suspension and air, a prone single-contrast phase with a low-density barium suspension, and mucosal-relief views with either density of barium suspension [35]. Double-contrast technique provides more mucosal information such as mucosal irregularities, erosions, or ulcers, and hiatal hernia and lower esophageal rings or strictures are best evaluated on the single-contrast view [35].

CT Abdomen and Pelvis Without IV Contrast. There is no relevant literature to support the use of CT abdomen and pelvis without IV contrast for this clinical scenario.

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 for this clinical scenario.

CT Abdomen Without and With IV Contrast. There is no relevant literature to support the use of CT abdomen without and with IV contrast for this clinical scenario.

Variant 2: Adult. Epigastric pain with known or suspected chronic symptoms of upper gastrointestinal tract inflammatory or infectious etiology. Initial imaging

In this variant, the focus is on GERD, esophagitis, gastritis, and PUD. Hiatal hernia will also be mentioned as it can cause and/or worsen GERD. This variant is also applicable to recurrent GERD and hiatal hernia in the setting of post antireflux procedures and surgeries, in addition to intrathoracic migration, paraesophageal herniation, evaluation of anatomy, and fundoplication wrap integrity.

The goal of imaging is to diagnose or detect acid reflux, esophagitis, gastritis, and peptic ulcer. This imaging information improves patient outcomes by determining whether there is acid reflux, hiatal hernia, esophagitis, gastritis, or peptic ulcer, thereby guiding appropriate management. The imaging information benefits the patient by reducing potential delay in appropriate and timely treatment and management, and potentially decreases the possibilities of associated complications from these disease entities. GI bleeding will not be discussed here.

The goal of imaging is to diagnose or detect postsurgical or postprocedural complications related to antireflux surgeries. Complications that can occur after laparoscopic antireflux surgery include intrathoracic migration and paraesophageal herniation [11]. This imaging information improves patient outcomes by determining whether complications are present, thereby guiding appropriate management. The imaging information benefits the patient by reducing potential delay in appropriate and timely treatment and management. For postoperative imaging evaluation in gastric bypass surgery, please see the ACR Appropriateness Criteria® topic on “Preoperative and Postoperative Imaging for Bariatric Procedures” [12].

Approximately 42% of Americans experience heartburn at least once a month and as many as 7% having multiple episodes every day [36], which makes GERD a commonly encountered disorder by the medical professional. However, diagnosis of GERD is not straightforward, and this is

attributed to nonspecific symptoms, which oftentimes overlap with other conditions [36]. GERD questionnaires, esophageal manometry, esophageal pH testing, imaging examinations, and upper endoscopy are routinely used for diagnosis [36].

Hiatal hernias may cause and/or worsen GERD, which makes diagnosis and evaluation of hiatal hernias relevant in a patient with GERD symptoms. Hiatal hernias are not uncommon, affecting 10% to 50% of the population with sliding hernias accounting for more than 85% of hiatal hernias and paraesophageal hernias accounting for up to 5% of all operated hiatal hernias [37]. Dietary modification and short-term treatment course of proton pump inhibitor may cure reflux symptoms related to hiatal hernias with no additional testing necessary [38]. However, in patients with severe symptoms, a large or paraesophageal hiatal hernia may require surgical treatment.

The prevalence of PUD has decreased due to early diagnosis, *Helicobacter pylori* infection treatment, and the use of proton pump inhibitors [39]. The importance of making the diagnosis of PUD is related to its complications, which are seen in 2% to 10% of cases since PUD-related perforation is a surgical emergency with a high mortality rate of up to 30% [21,39]. The standard test of choice for diagnosis is endoscopy; however, imaging may also help identify both PUD and its related complications such as perforation, which is discussed in [Variant 1](#).

Of note, throughout [Variant 2](#), the “Chest CT” procedures refer to chest CT examinations routinely performed.

Fluoroscopy Biphasic Esophagram. Fluoroscopy is an important radiologic modality in evaluating patients with epigastric pain due to or with suspected GERD, esophagitis, PUD, or hiatal hernia. Depending on the symptoms, evaluation may be performed with an esophagram/barium swallow, an upper GI series, or a combination of the two.

A biphasic fluoroscopic evaluation of the esophagus includes single- and double-contrast techniques, including an upright double-contrast phase where the two contrasts are a high-density barium suspension and air, a prone single-contrast phase with a low-density barium suspension, and mucosal-relief views with either density of barium suspension [35]. Double-contrast technique provides more mucosal information such as mucosal irregularities, erosions, or ulcers, and hiatal hernia and lower esophageal rings or strictures are best evaluated on the single-contrast view [35].

Barium esophagram provides anatomic and functional information on esophageal length and motility, presence, and size of hiatal hernia, diverticulum, esophageal stricture, as well as the presence of gastroesophageal reflux events with provocation [36]. Single-contrast examinations have a

reported sensitivity of 77% for detecting endoscopically proven esophagitis. Double-contrast examinations have a higher sensitivity of 80% because of their ability to reveal mucosal abnormalities that cannot be visualized on single-contrast studies. An even higher sensitivity of 88% is achieved by using a combined technique [35,40,41]. As such, a combined technique is most favorable for this assessment.

Fluoroscopic barium examinations can complement endoscopy in the diagnosis of a hiatal hernia, with more accurate depiction of anatomic features and other factors, which can contribute to severity of reflux symptoms such as hiatal hernia size, opening of the gastroesophageal junction, and loss of the angle of Hiss [36,38,42,43]. Barium examinations can better differentiate sliding hiatal hernias from paraesophageal hernias when compared with endoscopy [36]. This is important as this determines the surgical approach, which differs between sliding and paraesophageal hiatal hernias [38,43]. According to the ICARUS (International Consensus Regarding Preoperative Examinations and Clinical Characteristics Assessment to Select Adult Patients for Antireflux Surgery) guidelines, barium esophagram is mandatory in the preoperative workup for antireflux surgery in patients with suspected hiatal hernia or a short esophagus [44].

Fluoroscopy Upper GI Series. A double-contrast upper GI series is a biphasic examination where both double-contrast and single-contrast views are taken of the esophagus, stomach, and duodenum [45]. The double-contrast upper GI series uses both barium and air and adequate distension of the structures is needed [45]. Double-contrast upper GI series is beneficial for the evaluation of structural and functional abnormalities of the esophagus, stomach, and duodenum [46].

Fluoroscopic evaluation of the esophagus may reveal findings of esophagitis as detailed above. Furthermore, this procedure can help with the evaluation of gastritis, which can be seen as enlarged *areae gastricae*, disruption of the normal polygonal *areae gastricae* pattern by multiple uniform nodules, thickened gastric folds, erosions, or an ulcer with smooth folds radiating to the margin. Conversely, findings suggestive of malignancy include an ulcer associated with nodularity of the adjacent mucosa, mass effect, or coarse, lobulated, or irregular radiating folds [46]. This examination should be performed when symptoms are nonspecific and differential possibilities of esophagitis, gastritis, or PUD are being considered. The double-contrast upper GI series is a useful examination for the diagnosis, characterization, and evaluation of a hiatal hernia [38]. According to the Consensus Statement of Society of Abdominal Radiology Disease-Focused Panel on Barium Esophagography in Gastroesophageal Reflux

Disease, single-contrast images can evaluate for hiatal hernias; however, specific positioning may be required to improve visualization of small sliding hernias, which may not be seen when the patient is upright [47].

After procedural antireflux treatment, fluoroscopy upper GI series should be performed to evaluate the fundoplication wrap integrity and location, esophageal emptying impairment, stomach slippage above the diaphragm, and development or recurrence of a hiatal hernia [17].

Fluoroscopy Single-Contrast Esophagram. Although a biphasic examination is preferred to a single-contrast examination to assess for reflux/esophagitis and mucosal irregularities, a single-contrast examination may be necessary because of patient capabilities. A single-contrast examination may be helpful by revealing reflux, lower esophageal rings, strictures, and hiatal hernia [35,48]. If the hiatal hernia is large, an upper GI series evaluation should be included for complete assessment of the stomach.

After antireflux surgery, there is no consensus for the routine performance of postoperative esophagram to assess for postoperative leak. Thus, these studies are performed per institutional/surgeon preference, usually between day 1 and day 3 after surgery [11].

CT Abdomen and Pelvis With IV Contrast. For initial imaging of GERD, esophagitis, gastritis, or PUD, a CT examination is not the test of choice. However, patients may undergo a CT abdomen and pelvis as the initial diagnostic test for evaluation due to many of these entities exhibiting nonspecific or overlapping symptoms with other disease processes [39].

The CT examination should be performed with IV contrast. The addition of IV contrast markedly improves the conspicuity of findings such as mucosal hyperenhancement and interrupted enhancement, improving the sensitivity of diagnosis with CT [48]. A neutral oral contrast, such as water or dilute barium suspension, may also be administered; however, positive oral contrast should not be used as it can impede assessment of mucosal enhancement [48].

For the diagnosis of hiatal hernia, there is no relevant literature to support the use of CT abdomen and pelvis with IV contrast. However, after antireflux surgeries, CT abdomen with IV contrast is useful in the evaluation of symptoms as it can identify complications, such as abscess, and in the setting of fundoplication, the location and integrity of the wrap, stomach slippage above the diaphragm, and development or recurrence of a hiatal hernia, and help evaluate for the need for redo surgery [24,25]. Several studies used positive oral contrast [25,26]; however, there are no data in the literature that specifically compares the use of positive oral contrast versus no positive oral contrast use. The pelvis portion of the

examination may not be necessary in the evaluation of gastric and duodenal etiologies.

CT Abdomen With IV Contrast. The CT examination should be performed with IV contrast. The addition of IV contrast markedly improves the conspicuity of findings such as mucosal hyperenhancement and interrupted enhancement, improving the sensitivity of diagnosis with CT [48]. A neutral oral contrast, such as water or dilute barium suspension, may also be administered; however, positive oral contrast should not be used as it can impede assessment of mucosal enhancement [48].

There is no relevant literature to support the use of CT abdomen with IV contrast for initial imaging for hiatal hernia. However, CT can be useful in evaluating the complications of a hiatal hernia with assessment of intrahernia content, dimensions of the hernia, and complications such as gastric volvulus [49]. Also, after antireflux surgeries, CT abdomen with IV contrast is useful in the evaluation of symptoms as it can identify complications, such as abscess and in the setting of fundoplication, the location and integrity of the wrap, stomach slippage above the diaphragm, and development or recurrence of a hiatal hernia, and help evaluate for the need for redo surgery [24,25]. Several studies used positive oral contrast [25,26]; however, there are no data in the literature that specifically compares the use of positive oral contrast versus no positive oral contrast use.

CT Abdomen Without IV Contrast. There is no relevant literature to support the use of CT abdomen without IV contrast for this clinical scenario, but may be useful in some certain circumstances such as perforation per expert opinion.

In the post antireflux surgery or procedure setting, a CT abdomen examination without IV contrast can be useful with accurate depiction of anatomy [26].

CT Chest and Abdomen With IV Contrast. The CT examination should be performed with IV contrast. The addition of IV contrast markedly improves the conspicuity of findings such as mucosal hyperenhancement and interrupted enhancement, improving the sensitivity of diagnosis with CT [48]. A neutral oral contrast, such as water or dilute barium suspension, may also be administered; however, positive oral contrast should not be used as it can impede assessment of mucosal enhancement [48].

For diagnosis of reflux esophagitis on CT chest with IV contrast, distal esophageal wall thickening of ≥ 5 mm has an area under the receiver operating characteristic curve of 0.78, sensitivity of 56%, and specificity of 88% [50]. Although CT may occasionally show morphological

changes in the gastroesophageal junction in patients with reflux esophagitis, CT is not typically used for this indication [21].

There is no relevant literature to support the use of CT chest and abdomen with IV contrast for initial imaging for hiatal hernia. However, CT can be useful in evaluating the complications of a hiatal hernia with assessment of intra-hernia content, dimensions of the hernia, and complications such as gastric volvulus [49]. Also, after antireflux surgeries, CT abdomen with IV contrast is useful in the evaluation of symptoms as it can identify complications, such as abscess and in the setting of fundoplication, the location and integrity of the wrap, stomach slippage above the diaphragm, and development or recurrence of a hiatal hernia, and help evaluate for the need for redo surgery [24,25]. Several studies used positive oral contrast [25,26]; however, there are no data in the literature that specifically compares the use of positive oral contrast versus no positive oral contrast use. The pelvis portion of the examination may not be necessary.

CT Abdomen and Pelvis Without IV Contrast. There is no relevant literature to support the use of CT abdomen and pelvis without IV contrast for this clinical scenario. The pelvis portion of the examination may not be necessary in the evaluation of gastric and duodenal etiologies.

CT Chest With IV Contrast. For diagnosis of reflux esophagitis on CT chest with IV contrast, distal esophageal wall thickening of ≥ 5 mm has an area under the receiver operating characteristic curve of 0.78, sensitivity of 56%, and specificity of 88% [50]. Although CT may occasionally show morphological changes in the gastroesophageal junction in patients with reflux esophagitis, CT is not typically used for this indication [21].

There is no relevant literature to support the use of CT chest with IV contrast for initial imaging for hiatal hernia. However, CT can be useful in evaluating the complications of a hiatal hernia with assessment of intra-hernia content, dimensions of the hernia, and complications such as gastric volvulus [49].

CT Chest Without and With IV Contrast. There is no relevant literature to support the use of CT chest without and with IV contrast for this clinical scenario.

CT Chest Without IV Contrast. There is no relevant literature to support the use of CT chest without IV contrast for this clinical scenario.

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 for this clinical scenario. The pelvis portion of the examination may not be necessary in the evaluation of gastric and duodenal etiologies.

CT Abdomen Without and With IV Contrast. There is no relevant literature to support the use of CT abdomen without and with IV contrast for this clinical scenario.

CT Chest and Abdomen Without and With IV Contrast. There is no relevant literature to support the use of CT chest and abdomen without and with IV contrast for this clinical scenario.

CT Chest and Abdomen Without IV Contrast. There is no relevant literature to support the use of CT chest and abdomen without IV contrast for this clinical scenario.

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:** For initial imaging in adults with new or acute epigastric pain with suspected upper GI tract source, CT abdomen and pelvis with IV contrast, CT abdomen with IV contrast, CT chest without and with IV contrast, and CT chest and abdomen with IV contrast are usually appropriate. Fluoroscopy single-contrast esophagram, fluoroscopy upper GI series, radiography chest, abdomen, and pelvis, CT abdomen without IV contrast, and CT chest and abdomen without IV contrast may be appropriate. There is disagreement regarding CT chest with IV contrast and CT chest without IV contrast in terms of these procedures that may be appropriate in the evaluation of this variant.

■ **Variant 2:** For initial imaging in adults with epigastric pain with known or suspected chronic symptoms of upper GI tract inflammatory or infectious etiology, fluoroscopy biphasic esophagram or fluoroscopy upper GI series is usually appropriate. Fluoroscopy single-contrast esophagram, CT abdomen with IV contrast, CT abdomen without IV contrast, or CT chest and abdomen with IV contrast may be appropriate. There is disagreement regarding CT abdomen and pelvis with IV contrast in terms of this procedure that may be appropriate in the evaluation of this variant.

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 [51].

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 2). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [52].

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