American College of Radiology
ACR Appropriateness Criteria®

Staging and Follow-up of Esophageal Cancer

Variant: 1 Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT chest and abdomen with IV contrast	Usually Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Appropriate	☢☢☢☢
MRI chest and abdomen without and with IV contrast	May Be Appropriate	O
FDG-PET/MRI skull base to mid-thigh	May Be Appropriate	☢☢☢
CT chest abdomen pelvis with IV contrast	May Be Appropriate (Disagreement)	☢☢☢☢
Radiography chest	Usually Not Appropriate	☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
MRI chest and abdomen without IV contrast	Usually Not Appropriate	O
CT chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest abdomen pelvis without 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	☢☢☢☢

Variant: 2 Esophageal cancer. Imaging during treatment.

Procedure	Appropriateness Category	Relative Radiation Level
FDG-PET/CT skull base to mid-thigh	Usually Appropriate	☢☢☢☢
MRI chest and abdomen without and with IV contrast	May Be Appropriate	O
FDG-PET/MRI skull base to mid-thigh	May Be Appropriate	☢☢☢
Radiography chest	Usually Not Appropriate	☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
MRI chest and abdomen without IV contrast	Usually Not Appropriate	O
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	☢☢☢☢
CT chest and abdomen 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	☢☢☢☢

Variant: 3 Esophageal cancer. Posttreatment imaging. No suspected or known recurrence.

Procedure	Appropriateness Category	Relative Radiation Level
CT chest and abdomen with IV contrast	Usually Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Appropriate	☢☢☢☢
CT chest abdomen pelvis with IV contrast	May Be Appropriate	☢☢☢☢
Radiography chest	Usually Not Appropriate	☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
MRI chest and abdomen without and with IV contrast	Usually Not Appropriate	O

MRI chest and abdomen without IV contrast	Usually Not Appropriate	O
FDG-PET/MRI skull base to mid-thigh	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	☢☢☢☢
CT chest and abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest and abdomen without IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 4 Esophageal cancer. Posttreatment imaging. Suspected or known recurrence.

Procedure	Appropriateness Category	Relative Radiation Level
CT chest and abdomen with IV contrast	Usually Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Appropriate	☢☢☢☢
CT chest abdomen pelvis with IV contrast	May Be Appropriate (Disagreement)	☢☢☢☢
Radiography chest	Usually Not Appropriate	☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
MRI chest and abdomen without and with IV contrast	Usually Not Appropriate	O
MRI chest and abdomen without IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
FDG-PET/MRI skull base to mid-thigh	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	☢☢☢☢
CT chest and abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest and abdomen without IV contrast	Usually Not Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

Esophageal cancer is the eighth most common cancer and the sixth most common cause of cancer death worldwide. The American Cancer Society estimates there will be 19,260 new cases of and 15,530 deaths from esophageal cancer in the United States in 2021 [1]. Squamous cell carcinoma and adenocarcinoma comprise 98% of malignant tumors of the esophagus. Worldwide, squamous cell carcinoma is still more common, but in Western countries, adenocarcinoma now predominates and accounts for more than 60% of cases. In general, squamous cell carcinoma usually occurs in the upper and middle esophagus, whereas adenocarcinoma predominates in the lower esophagus [2].

For esophageal cancers, initial clinical staging uses a combination of imaging modalities with biopsies used to confirm suspected sites of disease. Specific strategies for the evaluation of the patient with esophageal cancer vary by institution not only in terms of the modalities used but in the order in which they are used. One common strategy is initial esophagogastroduodenoscopy and esophageal ultrasound (US) to determine cell type, grade, local extent, and locoregional nodal involvement followed by fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT to provide additional information on nodal disease and to evaluate for distant metastases. Another common strategy involves using CT or FDG-PET/CT first to evaluate for findings of metastatic disease. If metastatic disease is found, further evaluation with esophagogastroduodenoscopy and esophageal US may not be warranted [3]. The identification of distant metastatic disease is critical in the evaluation of the patient with newly diagnosed esophageal cancer because it will direct them to a treatment pathway centered on palliative chemoradiation rather than surgery. A secondary concern is the confirmation of locoregional spread because this is often an important determinant in whether neoadjuvant chemoradiation is used. If neoadjuvant chemoradiation is employed, follow-up imaging before definitive surgical treatment is necessary. Although the utility of follow-up imaging, particularly FDG-PET/CT, is of debate during and after neoadjuvant therapy to predict response, it does have a critical role in evaluating for the interval development of distant metastases and is commonly used for this purpose.

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: Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging.

Variant 1: Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging. A. CT Chest and Abdomen

For the purposes of this document, CT examinations are considered as being performed with intravenous (IV) contrast. There is no relevant literature supporting the use of CT for evaluation of the extent of tumor extension into the esophageal wall in T1 to T3 tumors. There are, however, older studies that investigated the use of CT for the evaluation of extension into adjacent structures. Picus et al [4] reviewed CT examinations in 52 patients with esophageal carcinoma, 30 of whom had surgery or autopsy, and found that CT appearance correctly determined aortic involvement in 24 of 25 cases, with 5 indeterminate. Takashima et al [5] prospectively reviewed CT

examinations on 35 patients and the reported sensitivity, specificity, and accuracy for resectability (defined as absence of evidence of invasion of adjacent structures) to be 100%, 80%, and 84%, respectively. A meta-analysis by Puli et al [6] reviewed data from 49 studies and 2,558 patients and reported pooled sensitivity and specificity of 92.4% and 97.4%, respectively, in the diagnosis of T4 disease. Unlike CT, esophageal US can also evaluate wall involvement of lower T stage tumors, with the meta-analysis by Puli et al [6] reporting sensitivity and specificity for T1 tumors of 81.6% and 99.4%, T2 tumors of 81% and 96%, and T3 tumors of 91.4% and 94.4%, respectively.

There is no relevant literature supporting the use of CT for nodal staging. A study by Choi et al [7], which prospectively evaluated 109 patients with esophageal cancer, used a short-axis diameter of 8 mm for the determination of positive nodes and reported a sensitivity of 35% and specificity of 93% for CT. CT is limited in the evaluation of nodal metastatic disease because multiple studies have shown that nodal metastases often occur in small lymph nodes in patients with esophageal cancer. Foley et al [8] evaluated 112 patients with multiple modalities and reported an accuracy of 54.5%, a sensitivity of 55.4%, a sensitivity of 39.7%, and a specificity of 77.4% for CT. Foley et al [8] also reported that 82% of positive lymph nodes measured <6 mm. Similarly, Kajiyama et al [9] reported that two-thirds of 320 metastatic lymph nodes assessed by surgery were <5 mm, further reinforcing that preoperative anatomic imaging evaluation will have a limited role in the detection of nodal metastatic disease. In terms of clinical relevance, Bunting et al [10] prospectively studied 133 patients undergoing surgery and reported an N stage accuracy of 75.6%. Their conclusion was that staging accuracy of locoregional disease with respect to the neoadjuvant threshold was poor with all modalities, including CT, and could potentially lead to over- and undertreatment.

The principle use of CT in the initial evaluation of patients with esophageal cancer is in detecting metastatic disease. CT has been compared with PET and FDG-PET/CT by several authors. Heeren et al [11] compared combined CT/esophageal US with PET and reported that sensitivity for distant nodal and systemic metastatic disease increased from 37% with CT/esophageal US to 78% with PET. Similarly, Hocazade et al [12] prospectively evaluated 91 patients with PET/CT and CT and reported that 47.3% of patients had metastases detected on PET/CT that were not detected by CT. Thus, although CT can detect metastases in the setting of esophageal cancer, it has been found to be less sensitive than PET and FDG-PET/CT even when combined with esophageal US.

The described literature presented here is based on contrast-enhanced CT. There are no reliable studies reporting the use of CT without IV contrast. When CT is used in the initial staging of esophageal cancer, contrast is recommended for optimal performance.

Variant 1: Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging. B. CT Chest, Abdomen, and Pelvis

For the purposes of this document, CT examinations are considered as being performed with IV contrast. Including the pelvis in CT for esophageal cancer would not affect the performance of CT for locoregional staging. The studies presented above by Heeren et al [11] and Hocazade et al [12] for the evaluation of systemic metastatic disease used CT of the chest and abdomen only. There are no studies that directly compare CT of the chest and abdomen with CT of the chest, abdomen, and pelvis; thus, the utility or added value of including the pelvis for the initial staging of esophageal cancer is not known.

Variant 1: Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging. C. FDG-PET/CT Skull Base to Mid-Thigh

Although there have been many studies evaluating the use of FDG-PET/CT in the evaluation of the primary tumor for prognosis, data supporting its use for T and N staging are limited. Walker et al [13] prospectively evaluated 81 patients with esophageal cancer with FDG-PET/CT and esophageal US and determined that esophageal US was superior to FDG-PET/CT for T staging and identifying locoregional lymph nodes. Hsu et al [14] investigated the use of PET/CT in 45 patients undergoing surgical resection for esophageal cancer and found that the maximum standardized uptake value $(SUV)_{max}$ showed potential in differentiating T1 from higher T stage tumors. In the same study, however, the sensitivity, specificity, and accuracy of PET/CT for nodal involvement were 57.1%, 83.3%, and 71.1%, respectively. Foley et al [8] also reported sensitivity, specificity, and accuracy of FDG-PET/CT of 77.3%, 75%, and 90.9%, respectively, for nodal involvement in a prospective study of 112 patients with esophageal cancer. Given that 82% of lymph node metastases were <6 mm in this study, the authors concluded that imaging staging for N disease was poor. Bunting et al [10] prospectively evaluated 133 patients with esophageal cancer undergoing surgery and reported an N stage accuracy of 78.6% for FDG-PET/CT. Bunting et al [10] also concluded that staging accuracy with respect to the threshold for treatment for neoadjuvant chemoradiation was poor and could lead to over- and undertreatment. A meta-analysis by van Westreenen et al [15] reported pooled sensitivity of 51% and specificity of 84% for FDG-PET/CT for locoregional metastases. Limited performance of FDG-PET/CT in locoregional staging is likely due to poor spatial resolution of PET and the reality that metastatic lymph nodes in esophageal cancer are often small. Even some primary tumors may not be detected with FDG-PET/CT either because of small size or in histologic subtypes with low FDG uptake [2].

There are many studies that have evaluated the use of FDG-PET/CT in detecting M disease in initial staging. Heeren et al [11] investigated 74 patients with FDG-PET/CT and found that FDG-PET/CT increased detection of M1 disease from 37% to 78% in comparison with CT/esophageal US. Vyas et al [16] prospectively investigated 114 patients with biopsy-proven esophageal adenocarcinoma and reported a sensitivity of 57.14% and specificity of 84.53% in detecting metastatic disease. A larger meta-analysis by van Westreenen et al [15] reported a pooled sensitivity and specificity for FDG-PET/CT of 67% and 97%, respectively, in the detection of M1 disease in esophageal cancer.

In terms of effects on clinical staging, You et al [17] prospectively evaluated 491 patients with esophageal cancer with FDG-PET/CT and reported clinically important stage changes in 188 (24%) patients. In a smaller cohort, Williams et al [18] reported the use of FDG-PET/CT changing initial staging in 10 of 38 (26%) patients with esophageal cancer, with 7 of 38 (18%) patients having a concomitant management change.

Variant 1: Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging. D. FDG-PET/MRI Skull Base to Mid-Thigh

There are no substantial data supporting the use of FDG-PET/MRI in the staging of esophageal cancer. In a small study evaluating 19 patients with esophageal cancer who underwent esophageal US, CT, FDG-PET/CT, and FDG-PET/MRI, Lee et al [19] reported acceptable T staging compared with esophageal US and statistically nonsignificant but higher accuracy than esophageal US and FDG-PET/CT for N staging. Impact on M staging was not reported. Given available data on the performance of FDG-PET/CT in the evaluation of M disease, it would be expected that FDG-PET/MRI may have similar potential, but data supporting its use are not yet available.

Variant 1: Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging. E. Fluoroscopy Upper GI Series

There is no relevant literature to support the use of fluoroscopy upper gastrointestinal (GI) series in the staging of esophageal cancer.

Variant 1: Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging. F. MRI Chest and Abdomen

There is only limited evidence supporting the use of MRI chest and abdomen in the evaluation of patients with esophageal cancer. Giganti et al [20] compared MRI, CT, esophageal US, and FDG-PET/CT in 27 patients with esophageal cancer. In this small study, contrast-enhanced MRI with diffusion-weighted imaging showed higher specificity (92%) and accuracy (82%) for T staging, but esophageal US was the most sensitive modality. MRI showed the highest reported accuracy for N stage (66%) in this study, although this would be in line with values previously determined for other imaging modalities. Qu et al [21] prospectively evaluated the use of contrast-enhanced radial VIBE sequences in the T staging of 43 patients with esophageal cancer and determined higher accuracy with MRI for T3 and T4 tumors. Malik et al [22] compared FDG-PET/CT and whole-body MRI in 49 patients, reporting similar performance for locoregional staging. Both modalities identified distant metastases that were present in 2 of the patients.

Variant 1: Newly diagnosed esophageal cancer. Pretreatment clinical staging. Initial imaging. G. Radiography Chest

There is no relevant literature to support the use of chest radiography in the initial staging of patients with esophageal cancer.

Variant 2: Esophageal cancer. Imaging during treatment.

Variant 2: Esophageal cancer. Imaging during treatment.
A. CT Chest and Abdomen

For the purposes of this document, CT examinations are considered as being performed with IV contrast. There is no relevant literature supporting the use of CT in patients who have undergone neoadjuvant chemoradiation. There are 2 studies that discourage its use for the evaluation of tumor response. In a study investigating 39 patients, van Heijl et al [23] reported that tumor volume changes identified on CT at 14 days were not associated with histopathologic tumor response. In a study evaluating the use of CT before and after neoadjuvant therapy in 35 patients with esophageal cancer, Konieczny et al [24] determined that CT accurately predicted complete histopathologic response in 20% and overstaged in 80%. An older systematic review by Westerterp et al [25] that reviewed 4 studies with CT showed the maximum joint value for sensitivity and specificity for CT in predicting response to neoadjuvant therapy was 54%. It should be noted that another important purpose of imaging patients after neoadjuvant therapy is to evaluate for the interval development of metastases. Although there are no studies evaluating CT specifically for this purpose, it would be expected to perform similarly to initial staging.

Variant 2: Esophageal cancer. Imaging during treatment.
B. CT Chest, Abdomen, and Pelvis

There is no relevant literature to support the inclusion of the pelvis in CT examinations during treatment.

Variant 2: Esophageal cancer. Imaging during treatment.
C. FDG-PET/CT Skull Base to Mid-Thigh

There are conflicting data on the use of FDG-PET/CT for the evaluation of patients undergoing neoadjuvant chemotherapy. A systematic review of the literature in 2004 by Westerterp et al [25]

assessed 7 studies using FDG-PET for the assessment of response to neoadjuvant chemotherapy in esophageal cancer. The maximum joint sensitivity and specificity for FDG-PET for in detecting response was 85%, with an accuracy similar to esophageal US and superior to CT. Subsequent studies showed promising results for FDG-PET/CT. Gabrielson et al [26] prospectively evaluated 51 patients undergoing neoadjuvant chemotherapy for esophageal cancer and found that SUVs could be used to differentiate responders from nonresponders but were not found to demonstrate statistical significance in patients with complete versus subtotal response. Beukinga et al [27] prospectively evaluated 74 patients using a radiomics-based quantitative assessment of postneoadjuvant chemoradiation FDG-PET/CT examinations and concluded that posttreatment FDG-PET/CT orderliness combined with clinical T staging resulted in high discriminatory accuracy in predicting complete histopathologic response. Thurau et al [28] conducted a retrospective review of 83 patients with esophageal cancer who had FDG-PET/CT performed at 6 weeks after induction of neoadjuvant therapy. The authors reported that an SUV reduction of >50% correlated with major histomorphologic response and that patients with this reduction also showed significantly increased survival.

Other authors, however, found fewer promising results when evaluating FDG-PET/CT for the assessment of response to neoadjuvant therapy. Vallbohmer et al [29] prospectively evaluated 119 patients with FDG-PET/CT 2 to 3 weeks after induction of neoadjuvant chemotherapy and found no significant association between major responders and FDG-PET/CT results; receiver operating characteristic analysis could not identify an SUV threshold to predict histomorphologic response, and there was no association between metabolic imaging and prognosis. Elliot et al [30] prospectively evaluated 100 patients with esophageal cancer who underwent FDG-PET/CT at 2 to 4 weeks after completion of neoadjuvant therapy and concluded FDG-PET/CT had poor prognostic value and clinical application for determining responders. Piessen et al [31] prospectively evaluated 46 patients with esophageal cancer who had FDG-PET/CT performed 4 to 6 weeks after completion of neoadjuvant therapy and concluded that FDG-PET/CT did not correlate with pathological response and long-term survival in patients with locally advanced esophageal cancer. Van Heijl et al [32] prospectively studied patients with esophageal cancer who had FDG-PET/CT at 2 weeks after the induction of chemotherapy and found FDG-PET/CT showed a statistically significant decrease in SUV in responders and correctly identified 58 of 64 responders and 18 of 36 nonresponders. The authors concluded that the low accuracy in detecting nonresponders did not justify using FDG-PET/CT for early discontinuation of neoadjuvant chemotherapy.

FDG-PET/CT also has the potential to detect metastases that have developed in the interval after the induction of neoadjuvant therapy. A systematic review and meta-analysis performed by Kroese et al [33] evaluated 14 studies (1,110 patients) and found a pooled proportion of 8% of patients having interval metastases detected by FDG-PET/CT. The authors also reported an additional pooled proportion of 5% of patients who had false-positive concerning distant findings. Kroese et al [33] concluded that the detection of distant metastases on restaging FDG-PET/CT after induction of neoadjuvant therapy can considerably impact decision making but that suspicious imaging findings required pathologic confirmation.

Variant 2: Esophageal cancer. Imaging during treatment.
D. FDG-PET/MRI Skull Base to Mid-Thigh

There is no relevant literature to support the use of FDG-PET/MRI during treatment.

Variant 2: Esophageal cancer. Imaging during treatment.

E. Fluoroscopy Upper GI Series

There is no relevant literature to support the use of fluoroscopy upper GI series during treatment.

Variant 2: Esophageal cancer. Imaging during treatment.
F. MRI Chest and Abdomen

There are limited data from small series investigating the use of MRI for the evaluation of patients undergoing treatment. A prospective study of 26 patients undergoing neoadjuvant therapy for esophageal cancer who underwent dynamic contrast-enhanced MRI by Heethuis et al [34] demonstrated that the area under the curve could predict good responders and poor responders with a sensitivity of 92% and a specificity of 77%. Sun et al [35] used dynamic contrast-enhanced MRI to evaluate patients with advanced squamous cell cancer of the esophagus and reported that the change in K^{trans} was a parameter that could be potentially used to assess treatment response. Wang et al [36] studied 38 patients with squamous cell cancer of the esophagus undergoing chemoradiotherapy with weekly MRI including diffusion-weighted imaging. The authors reported that treatment-induced change in apparent diffusion coefficient during the first 2 to 3 weeks could be used to assess response to therapy. Wang et al [37] prospectively studied 79 patients with esophageal cancer who had 3T MRI before and after neoadjuvant therapy and reported a sensitivity, specificity, and accuracy of more than 90% for several sequences in T staging after neoadjuvant therapy.

No studies are available that investigate the performance of MRI for detecting interval metastases in patients undergoing neoadjuvant therapy.

Variant 2: Esophageal cancer. Imaging during treatment.
G. Radiography Chest

There is no relevant literature to support the use of chest radiography during treatment.

Variant 3: Esophageal cancer. Posttreatment imaging. No suspected or known recurrence.

Variant 3: Esophageal cancer. Posttreatment imaging. No suspected or known recurrence.
A. CT Chest and Abdomen

For the purposes of this document, CT examinations are considered as being performed with IV contrast. CT has been studied in the evaluation of patients who have completed treatment. Recent data exist from studies comparing FDG-PET and FDG-PET/CT with contrast-enhanced CT in the detection of recurrence. Kato et al [38] studied 55 patients and reported 89% sensitivity, 79% specificity, and 84% accuracy for CT in detecting recurrent disease in comparison with 96% sensitivity, 68% specificity, and 82% accuracy for FDG-PET. The authors did note that CT was more sensitive than FDG-PET for the detection of lung metastases. Teyton et al [39] prospectively studied 41 patients postsurgery for esophageal cancer and reported 65% sensitivity and 91% specificity for chest and abdomen CT versus 100% sensitivity and 85% specificity for FDG-PET. Of note, in a retrospective review by Antonowicz et al [40], 169 patients who underwent esophagectomy and were followed with annual CT had no change in management or survival.

Variant 3: Esophageal cancer. Posttreatment imaging. No suspected or known recurrence.
B. CT Chest, Abdomen, and Pelvis

There are no specific studies comparing body CT scans that include the pelvis with those that do not in asymptomatic patients undergoing CT to evaluate for recurrent disease.

Variant 3: Esophageal cancer. Posttreatment imaging. No suspected or known recurrence.

C. FDG-PET/CT Skull Base to Mid-Thigh

Several studies have evaluated FDG-PET/CT in the evaluation of asymptomatic patients who have had definitive treatment for esophageal cancer. Betancourt et al [41] studied 162 asymptomatic patients who underwent surgery for esophageal cancer and were followed with FDG-PET/CT. They reported a sensitivity of 77% and specificity of 76% for recurrence at the anastomosis, sensitivity of 88% and specificity of 85% for regional node recurrence, and sensitivity of 97% and specificity of 96% for distant metastases. A systematic review of the literature by Goense et al [42] evaluating 486 patients across 8 studies reported a pooled sensitivity of 96% and a specificity of 78% in detecting recurrent disease. There was no statistically significant difference in the performance of FDG-PET/CT in patients who were asymptomatic or had a clinical indication for the examination.

Variant 3: Esophageal cancer. Posttreatment imaging. No suspected or known recurrence. D. FDG-PET/MRI Skull Base to Mid-Thigh

There is no relevant literature to support the use of FDG-PET/MRI to follow asymptomatic patients after treatment.

Variant 3: Esophageal cancer. Posttreatment imaging. No suspected or known recurrence. E. Fluoroscopy Upper GI Series

There is no relevant literature to support the use of fluoroscopy upper GI series to follow asymptomatic patients after treatment.

Variant 3: Esophageal cancer. Posttreatment imaging. No suspected or known recurrence. F. MRI Chest and Abdomen

There is no relevant literature to support the use of MRI chest and abdomen to follow asymptomatic patients after treatment.

Variant 3: Esophageal cancer. Posttreatment imaging. No suspected or known recurrence. G. Radiography Chest

There is no relevant literature to support the use of chest radiography to follow asymptomatic patients after treatment.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence. A. CT Chest and Abdomen

For the purposes of this document, CT examinations are considered as being performed with IV contrast. Sharma et al [43] studied 227 patients with suspected esophageal cancer who had suspected metastasis. All patients underwent FDG-PET/CT, whereas 109 patients also underwent contrast-enhanced CT. The authors reported a sensitivity of 96% and a specificity of 81% for FDG-PET/CT compared with a 97% sensitivity and a 21% specificity for contrast-enhanced CT.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence. B. CT Chest, Abdomen, and Pelvis

There are no specific studies comparing body CT scans that include the pelvis with those that do not in patients undergoing CT to evaluate for clinically suspected recurrent disease.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence. C. FDG-PET/CT Skull Base to Mid-Thigh

As above, Sharma et a [43] studied 227 patients with suspected esophageal cancer who had

suspected metastasis. All patients underwent FDG-PET/CT, whereas 109 patients also underwent contrast-enhanced CT. The authors reported a sensitivity of 96% and specificity of 81% for FDG-PET/CT compared with a 97% sensitivity and a 21% specificity for contrast-enhanced CT. Also, as discussed previously, a systematic review of the literature by Goense et al [42] evaluating 486 patients across 8 studies reported a pooled sensitivity of 96% and a specificity of 78% in detecting recurrent disease. There was no statistically significant difference in the performance of FDG-PET/CT in patients who were asymptomatic or had a clinical indication for the examination.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence. D. FDG-PET/MRI Skull Base to Mid-Thigh

There is no relevant literature to support the use of FDG-PET/MRI to evaluate patients suspected to have metastases after treatment.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence. E. Fluoroscopy Upper GI Series

There is no relevant literature to support the use of fluoroscopy upper GI series to evaluate patients suspected to have metastases after treatment.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence. F. MRI Chest and Abdomen

There is no relevant literature to support the use of MRI chest and abdomen to evaluate patients suspected to have metastases after treatment.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence. G. MRI Head

There is no relevant literature to support MRI brain to evaluate patients suspected to have metastases after treatment.

Variant 4: Esophageal cancer. Posttreatment imaging. Suspected or known recurrence. H. Radiography Chest

There is no relevant literature to support the use of chest radiography to evaluate patients suspected to have metastases after treatment.

Summary of Recommendations

- **Variant 1:** CT chest and abdomen with IV contrast or FDG-PET/CT skull base to mid-thigh is usually appropriate for the initial staging of patients with newly diagnosed esophageal cancer. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending CT chest, abdomen, and pelvis with IV contrast given that there is insufficient medical literature to conclude whether or not these patients would benefit from including the pelvis for this clinical scenario.
- **Variant 2**: FDG-PET/CT skull base to mid-thigh is usually appropriate for the evaluation of patients with esophageal cancer undergoing treatment.
- **Variant 3**: CT chest and abdomen with IV contrast or FDG-PET/CT skull base to mid-thigh is usually appropriate for patients who had esophageal cancer with no suspected or known recurrence after treatment. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the

patient's care).

- **Variant 4**: CT chest and abdomen with IV contrast or FDG-PET/CT skull base to mid-thigh is usually appropriate for patients with esophageal cancer with suspected or known recurrence after treatment. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending CT chest, abdomen, and pelvis with IV contrast given that there is insufficient medical literature to conclude whether or not these patients would benefit from including the pelvis for this clinical scenario.

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.

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 [44].

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 (eg, 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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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.

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