

**American College of Radiology
ACR Appropriateness Criteria®
Lung Cancer Screening**

Variant 1: Lung cancer screening. Patient 55 to 80 years of age and 30 or more packs per year smoking history and currently smoke or have quit within the past 15 years.

Procedure	Appropriateness Category	Relative Radiation Level
CT chest without IV contrast screening	Usually Appropriate	☼☼☼
CT chest with IV contrast	Usually Not Appropriate	☼☼☼
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☼☼☼☼
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
Radiography chest	Usually Not Appropriate	☼

Variant 2: Lung cancer screening. Patient 50 years of age or older and 20 or more packs per year history of smoking and one additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis).

Procedure	Appropriateness Category	Relative Radiation Level
CT chest without IV contrast screening	May Be Appropriate (Disagreement)	☼☼☼
CT chest with IV contrast	Usually Not Appropriate	☼☼☼
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☼☼☼☼
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
Radiography chest	Usually Not Appropriate	☼

Variant 3: Lung cancer screening. Patient younger than 50 years of age or patient older than 80 years of age or patient any age with less than 20 packs per year history of smoking and no additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis).

Procedure	Appropriateness Category	Relative Radiation Level
CT chest with IV contrast	Usually Not Appropriate	☼☼☼
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
CT chest without IV contrast screening	Usually Not Appropriate	☼☼☼
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☼☼☼☼
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
Radiography chest	Usually Not Appropriate	☼

LUNG CANCER SCREENING

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Summary of Literature Review

Introduction/Background

Lung cancer remains the leading cause of cancer death in both men and women [1]. Smoking is the single greatest risk factor for the development of lung cancer; additional risk factors include radon exposure, occupational exposure to asbestos or other carcinogens, personal history of cancer, family history of lung cancer, history of chronic obstructive pulmonary disease (COPD), and history of pulmonary fibrosis.

Both the treatment and prognosis for lung cancer depend upon the stage of the disease, with smaller and less-extensive tumors tending to have longer survivals. The goal of lung cancer screening is to detect early-stage disease before it becomes clinically evident and when appropriate treatment can lead to improved survival.

Special Imaging Considerations

Unlike conventional chest CT scans performed for other reasons, those done for the purpose of lung cancer screening should be performed using a technique to keep the radiation dose to the patient as low as reasonably achievable. In general, acceptable low-dose lung cancer screening CT scans should be performed according to the guidelines in the [ACR–STR Practice Parameter for the Performance and Reporting of Lung Cancer Screening Thoracic Computed Tomography \(CT\)](#) [2].

Discussion of Procedures by Variant

Variant 1: Lung cancer screening. Patient 55 to 80 years of age and 30 or more packs per year smoking history and currently smoke or have quit within the past 15 years.

CT Chest

The population described in this variant exactly matches the inclusion criteria of the National Lung Cancer Screening Trial, which showed that the use of low-dose chest CT resulted in a 20% reduction in lung cancer mortality [3]. There is no relevant literature regarding the use of CT with intravenous (IV) contrast for lung cancer screening.

In 2011, the results of the National Lung Cancer Screening Trial became available [3-16]. This study enrolled 53,454 participants ages 55 to 74 at entry, who were current or recent (quit within last 15 years) smokers with at least a 30 pack-years smoking history. This randomized controlled study demonstrated a 20% relative decrease in lung cancer mortality from screening high-risk smokers with low-dose CT.

Several other studies have evaluated the role of CT for screening high-risk patients. The Detection and Screening of Early Lung Cancer by Novel Imaging Technology and Molecular Essays Trial [17-20] and the Danish Lung Cancer Screening Trial [21-24] were two randomized controlled studies that failed to show a survival benefit from screening with low-dose CT. However, both studies were much smaller than the National Lung Cancer Screening Trial and were underpowered to detect a mortality difference. The Dutch-Belgian Lung Cancer Screening trial [25-32] is a randomized controlled clinical trial powered to detect a 25% reduction in lung cancer mortality in 10 years compared to no screening; the final results were not yet available at the time of this publication.

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The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

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MRI Chest

The role of MRI, with or without IV contrast, as a lung cancer screening modality has not been adequately studied.

FDG-PET/CT Skull Base to Mid-Thigh

Though PET using the tracer fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) has a high sensitivity and specificity for lung cancer, its role as a screening modality has not been adequately studied [33]. Minamimoto et al [34] studied FDG-PET/CT in 153,775 individuals with unknown smoking histories and found that the PET portion of the study showed “limited detectability” for small cancers.

Radiography Chest

Chest radiography screening does not reduce lung cancer mortality in this population and is inferior to CT [3]. Both the Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial [35-37] and the Mayo Lung Project [38] showed no improvement in mortality from screening with chest radiography. The Memorial Sloan-Kettering [39] and the Johns Hopkins studies [40] showed no survival benefit if sputum cytology was added to annual chest radiography compared to chest radiography alone; however, later analysis showed that had these studies been combined and the follow-up longer, a modest benefit may have been present [41].

Variation 2: Lung cancer screening. Patient 50 years of age or older and 20 or more packs per year history of smoking and one additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis).

CT Chest

There is insufficient evidence to determine if these patients would benefit from CT screening for lung cancer. There is no relevant literature regarding the use of CT with IV contrast for lung cancer screening.

MRI Chest

There is no evidence to support screening in this population with MRI, with or without IV contrast.

FDG-PET/CT Skull Base to Mid-Thigh

There is no evidence to support screening in this population with FDG-PET/CT.

Radiography Chest

There is no evidence to support screening in this population with chest radiography.

Variation 3: Lung cancer screening. Patient younger than 50 years of age or patient older than 80 years of age or patient any age with less than 20 packs per year history of smoking and no additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis).

CT Chest

There is no evidence to support screening in this population with chest CT, with or without IV contrast.

MRI Chest

There is no evidence to support screening in this population with MRI, with or without IV contrast.

FDG-PET/CT Skull Base to Mid-Thigh

There is no evidence to support screening in this population with FDG-PET/CT.

Radiography Chest

There is no evidence to support screening in this population with chest radiography.

Summary of Recommendations

- **Variation 1:** Lung cancer screening with low-dose CT chest without IV contrast is usually appropriate in patients 55 to 80 years of age and 30 or more packs per year smoking history and currently smokes or have quit within the past 15 years.
- **Variation 2:** The panel did not agree on recommending lung cancer screening with low-dose CT chest without IV contrast in patients 50 years of age or older and 20 or more packs per year history of smoking plus one additional risk factor. There is insufficient medical literature to conclude whether or not these patients would benefit from CT screening for lung cancer. Screening in this patient population is controversial but may be appropriate.

- **Variation 3:** Lung cancer screening is usually not appropriate in patients younger than 50 years of age or older than 80 years of age; or in patients of any age with less than 20 packs per year history of smoking and no additional risk factors.

Summary of Evidence

Of the 42 references cited in the *ACR Appropriateness Criteria® Lung Cancer Screening* document, 41 references are categorized as diagnostic references including 3 well-designed studies, 11 good-quality studies, and 15 quality studies that may have design limitations. There are 12 references that may not be useful as primary evidence. There is 1 reference that is a meta-analysis study.

The 42 references cited in the *ACR Appropriateness Criteria® Lung Cancer Screening* document were published from 1984 to 2018.

Although there are references that report on studies with design limitations, 14 well-designed or good-quality studies provide good evidence.

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 [42].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	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”.

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

References

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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.