American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Acute Respiratory Illness**

Variant 1: **Older than age 40.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	8		Min
CT chest without contrast	4		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 2: **Dementia, any age.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	8		Min
CT chest without contrast	4		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 3: **Younger than age 40, negative physical exam, and no other signs, symptoms, or risk factors.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	4		Min
CT chest without contrast	1		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 4: **Less than 40 years old, positive physical exam, or other risk factors.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		Min
CT chest without contrast	4		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 5: **Complicated pneumonia.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		Min
CT chest with or without contrast	8	If pneumonia is not resolving or intervention is contemplated.	Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Acute Respiratory Illness**

Variant 6: **Suspected SARS.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		Min
CT chest without contrast	9	If chest radiograph is normal or equivocal.	Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 7: **Suspected Anthrax.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		Min
CT chest with or without contrast	8	If chest radiograph is normal or equivocal.	Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 8: **Febrile, neutropenic.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		Min
CT chest with or without contrast	8	If chest radiograph is normal or equivocal.	Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 9: **Acute asthma uncomplicated.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	4		Min
CT chest without contrast	1		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 10: **Acute asthma, suspected pneumonia, pneumothorax.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		Min
CT chest without contrast	2		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Acute Respiratory Illness**

Variant 11: **Acute exacerbation of COPD, "uncomplicated" (no history of CAD or CHF, no leukocytosis, fever, or chest pain).**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	4		Min
CT chest without contrast	2		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 12: **Acute exacerbation of COPD with one or more of the following: leukocytosis, pain, history of CAD or CHF.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		Min
CT chest without contrast	4		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

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Summary of Literature Review

Acute respiratory illness (ARI) is defined as one or more of the following: cough, sputum production, chest pain, or dyspnea (with or without fever). The workup of a patient with ARI, including the need for chest radiography and computed tomography (CT), depends on many factors, including severity of the illness; age of patient; presence of fever, leukocytosis, or hypoxemia; clinical history; presence of other risk factors; and physical examination. Not all studies concur as to which patients with ARI should have chest radiographs.

Benacerraf et al [1] in a study of 1,102 outpatients with ARI, found patient age, the physical examination, and the presence or absence of hemoptysis to be important factors. Only 4% (7/175) of patients younger than age 40 with symptoms of ARI, a negative physical examination, and no hemoptysis had acute significant radiographic findings, whereas patients either older than age 40 with hemoptysis or with a positive physical examination had a much higher incidence of chest radiograph abnormalities. In a study of 464 patients with ARI, Heckerling also found a low incidence (3%) of pneumonia in patients with negative physical examinations [2]. A notable exception was found for patients with dementia, in whom the incidence of pneumonia was very high regardless of the results of the physical examination. Okimoto et al [3] studied 79 outpatients presenting with clinical suspicion of pneumonia and concluded that radiographs should be ordered only when patients present with fever, cough, sputum production, and coarse crackles on physical examination. Conversely, Butcher et al [4] in a study of 221 patients with ARI found that 77 (35%) had new clinically important findings. Furthermore, the clinical findings did not differ significantly between those with positive radiographic findings and those with negative findings (ie, clinical history and physical examination were poor predictors of radiography-detected abnormality). Speets et al [5] evaluated 192 patients with a clinical suspicion of pneumonia by general practitioners and found that the probability of pneumonia was changed by chest radiographic results in 53% of patients, with a decrease in probability in 47% and an increase in probability in 6%.

In a series of 300 patients with acute cough illness, Aagard et al [6] found that for patients with a high pretest probability of pneumonia, a radiograph was not always obtained in clinical practice; they infer that when the clinical probability of pneumonia exceeds a certain level, a negative radiograph would not alter treatment decisions by clinicians. A series by Basi et al [7] that included 2,706 patients hospitalized with community-acquired pneumonia similarly showed that 911 (one-third) of patients had radiographs initially interpreted as negative for pneumonia, with minimal change in this interpretation on retrospective review of a random subgroup. The groups with positive and negative radiographs had similar rates of positive sputum cultures and blood cultures. These two studies call into question the utility of radiographs in patients with high pretest probability of pneumonia.

Patients with substance abuse have an increased risk of ARI due to two mechanisms: respiratory pump failure and pulmonary pathology [8]. Respiratory pump failure generally does not have radiographic manifestations. However pulmonary pathology includes multiple diagnosis with chest radiographic manifestations, including aspiration, pulmonary edema, pneumonia, hemorrhage, and septic emboli.

Jochelson et al [9] found a low incidence (4%) of pneumonia in febrile, but otherwise asymptomatic, neutropenic patients with a normal physical examination. Navigante et al [10] found a similarly low incidence (2.3%) of pneumonia at chest radiography in febrile neutropenic patients without clinical suspicion of pneumonia from history or physical examination. Heussel et al [11] evaluated the utility of thin-section CT in a group of febrile neutropenic patients with normal or nonspecific chest radiographs. There were 146 episodes in 87 patients. Among the 14% with nonspecific chest radiographs, CT suggested pneumonia in all. Forty-eight percent had a normal chest radiograph, but CT findings of pneumonia. Of these, a specific pathogen was identified in 43%. Both chest radiograph and CT findings were normal in 38%. The CT findings changed patient's therapy in 18%. Maertens et al [12] have proposed an algorithm employing CT in conjunction with galactomannan assays to select patients for high-dose antifungal therapy and performed a feasibility study assessing patients with 117 episodes of neutropenic fever.

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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 society endorsement of the final document.

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When the algorithm employing CT was used, only 4.4% of patients received antifungal therapy. Hachem et al [13] retrospectively analyzed CT scans and autopsy results in 96 cancer patients who died of pneumonia and found that the presence of nodules in neutropenic patients and cavitary lesions in non-neutropenic patients was highly associated with fungal infection.

According to the guidelines of the Infectious Diseases Society of the American and American Thoracic Society, chest radiography should be obtained whenever pneumonia is suspected in adults to establish the diagnosis and to aid in differentiating community-acquired pneumonia (CAP) from other common causes of cough and fever, such as acute bronchitis [14]. Findings on chest radiographs are one of several parameters used to determine: 1) which patients should be hospitalized (presence of pleural effusion); 2) which patients should be classified as having severe pneumonia (multilobar involvement); and 3) which patients may require additional diagnostic testing (cavitation, pleural effusion), including thoracentesis (pleural effusions >5 cm on lateral upright radiograph) [14]. CT may show findings in patients with normal radiographs, but the significance of these findings and therefore the utility of CT in patients with clinically suspected pneumonia and negative radiographs are unclear [14]. CT may play a role in the management of severe pneumonia. It can serve as a guide for pleural drainage or localize an appropriate site for biopsy [15]. Severe pneumonias bear a strong relationship to etiologic pathogens and have implications for antimicrobial treatment. Patients with severe pneumonia should be considered as candidates for admission to an intensive care unit.

The need for chest radiographs in adult patients with acute asthma is controversial. Petheram et al [16] found clinically important (ie, patient management affected) radiographic findings in 9% of their patients and concluded that chest radiography is indicated. However, Findley and Sahn [17] observed that 99% of their patients either had normal chest radiographic examinations or showed only slightly prominent markings or hyperinflation. Heckerling [2] reported that patients with acute asthma rarely have pneumonia. Findley and Sahn [17] recommended chest radiographs only when pneumonia or pneumothorax is suspected. White et al [18] found significant chest radiographic abnormalities in 34% of adults whose asthma exacerbation warranted admission to the hospital.

Sherman et al [19] studied the utility of chest radiography in 242 patients with acute exacerbations of chronic obstructive pulmonary disease (COPD) (ie, dyspnea). Of this group, 135 patients (56%) had asthma, and 107 (44%) had emphysema and chronic bronchitis. Chest radiographs were abnormal in 14% but resulted in significant change in management in only 4.5%. They concluded that the chest radiograph is indicated only if the worsening dyspnea is accompanied by leukocytosis, chest pain, or edema or by a history of coronary artery disease or congestive heart failure (CHF).

Emerging infections and biological warfare agents have come to recent attention as causes of ARI. Two infections that received a great deal of attention recently, but which have subsequently become less active concerns, are severe acute respiratory syndrome (SARS) and anthrax.

SARS emerged in China in late 2002. The etiologic agent is a novel coronavirus (SARS-CoV) that appears to have originated in Himalayan palm civets and crossed the species barrier. In February 2003 the Program for Monitoring Emerging Diseases identified this novel presentation of pneumonia which because of air travel, rapidly spread across continents to involve patients in at least 27 countries. There is literature supporting the utility of chest radiography in patients with known or suspected SARS. Wong et al [20] and Paul et al [21] described the chest radiographic findings of SARS during the Hong Kong and Toronto epidemics. Chest radiographs were abnormal in 78%-80% of patients at presentation. The most common chest radiographic finding was unifocal opacity with a peripheral and basilar predominance. Multifocal or diffuse opacities could be present initially or develop as the disease progressed. Patients whose disease progressed were generally older, had more comorbidities, and had a higher fatality rate. Cavitation, pleural effusion, and lymphadenopathy were not features of SARS. Antonio et al [22] studied 1,373 patients in Hong Kong with SARS and found a sensitivity for disease of 82.4% on initial chest radiographs; they also concluded that the initial extent of radiographic opacification had prognostic value and that the rate of radiographic progression could be used as a prognostic indicator.

Thin-section chest CT findings of SARS have been described by Wong et al [23], Chan et al [24], and Paul et al [21]. The most common findings are ground-glass opacities and crazy paving. More extensive findings include focal or multifocal consolidation. Chan et al [24] described pleural effusions and pneumomediastinum developing in 26% of patients scanned during the course of their illness. Hui et al [25] suggest that high-resolution computed tomography (HRCT) is useful for early diagnosis of SARS in patients with negative chest radiographs. They studied 47 patients with suspected SARS and normal chest radiographs; 25 of 27 patients with serologic confirmation of SARS had abnormal findings at HRCT and developed clinical SARS, while the two with negative HRCTs did not develop pulmonary infection.

Anthrax is endemic in the soil of Texas, Oklahoma, and the Mississippi Valley. During the 20th century a number of countries developed weapon-grade anthrax to be used as a biological warfare agent [26]. Much of modern medical experience with it arises from a Soviet military accident in 1979 in which 42 people died of anthrax, and from cases of anthrax that developed in the U.S. in 2001 as a result of biological warfare. Anthrax comes in three forms: cutaneous, gastrointestinal, and inhalational. Ninety-five percent of anthrax is cutaneous, but the inhalational form is the most deadly. Inhalation of anthrax spores leads to hemorrhagic lymphadenitis and

mediastinitis, sometimes accompanied by necrotizing pneumonia. The chest radiographic findings [26,27] include widened mediastinum and hila, often accompanied by pleural effusions and parenchymal opacities. Earls et al [27] described the CT findings in two patients who survived inhalational anthrax. The CT characteristics were very suggestive of the diagnosis and included hyperattenuating hilar and mediastinal lymphadenopathy and hemorrhagic pleural effusion. Less specific findings included mediastinal edema, peribronchial thickening, and pleural effusion.

Summary

Based on these studies, the chest radiograph seems warranted in ARI when one or more of the following are present: older than age 40; dementia; a positive physical examination; hemoptysis; associated abnormalities (leukocytosis, hypoxemia); or other risk factors, including coronary artery disease, CHF, or drug-induced acute respiratory failure. Chest radiography also seems warranted for any adult patient with clinical suspicion of pneumonia, although some clinicians may choose not to perform radiography if clinical suspicion of respiratory infection is sufficiently high to warrant treatment if a radiograph were to be negative. It appears that in patients with ARI, who are younger than age, chest radiography is not routinely indicated unless there are other abnormalities, a positive physical examination, or other risk factors. It also appears that chest radiographic examination is not indicated in most patients with exacerbations of COPD (including asthma) unless there is a suspected complication such as pneumonia or pneumothorax or unless one or more of the following are present: leukocytosis, chest pain, edema, or a history of coronary artery disease or CHF. Chest CT may be warranted in complicated cases of severe pneumonia and in febrile neutropenic patients with normal or nonspecific chest radiographic findings. In patients with a normal chest radiograph and a high clinical suspicion of SARS, CT can be helpful in making the diagnosis.

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

Relative Radiation Level Designations	
Relative Radiation Level	**Effective Dose Estimate Range**
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Evidence table under review

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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.