

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: Routine Chest Radiography

Variant 1: No clinical concern on basis of history or physical examination.

| Radiologic Procedure | Rating | Comments | RRL* |
|--|--------|----------|----------------------------------|
| X-ray chest routine preoperative | 3 | | ⊕ |
| X-ray chest routine admission | 3 | | ⊕ |
| X-ray chest routine outpatient | 2 | | ⊕ |
| <u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

Variant 2: Suspicion of acute or potentially unstable chronic cardiopulmonary disease by history or physical examination.

| Radiologic Procedure | Rating | Comments | RRL* |
|--|--------|----------|----------------------------------|
| X-ray chest routine admission | 9 | | ⊕ |
| X-ray chest routine preoperative | 8 | | ⊕ |
| X-ray chest routine outpatient | 8 | | ⊕ |
| <u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

Variant 3: Increased risk, patient- or procedure-related (ie, advanced age [particularly >70 years], unreliable history and physical examination, high-risk surgery).

| Radiologic Procedure | Rating | Comments | RRL* |
|--|--------|----------|----------------------------------|
| X-ray chest routine preoperative | 7 | | ⊕ |
| X-ray chest routine admission | 7 | | ⊕ |
| X-ray chest routine outpatient | 6 | | ⊕ |
| <u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

ROUTINE CHEST RADIOGRAPHY

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Summary of Literature Review

Introduction/Background

The concept of routine testing became engrained in medical practice in the 20th century with the development of technologies that could detect otherwise unsuspected abnormalities associated with increased morbidity or mortality and the potential need to alter clinical management. Chest radiography evolved into routine practice out of early screening programs devised to identify asymptomatic tuberculosis carriers [1]. Routine chest radiography came into question by the 1970s [2], although it persisted as part of a battery of routine testing frequently performed into the 1980s. Numerous studies since the 1980s have challenged the use of various routine tests, including the chest radiograph. This document reviews the routine chest radiograph performed on adult patients in association with elective preoperative and preintervention, hospital admission, and asymptomatic outpatient evaluation.

Routine Preoperative and Preprocedural Chest Radiographs

Data on the value of the preoperative chest radiograph have been largely derived from case series and cohort studies that date before 2000. There have been few systematic reviews and meta-analyses throughout the years, and little information has been derived from randomized controlled trials. Routine radiographs are not consistently distinguished from indicated ones in most reports, and the performance of single versus 2-view examinations is infrequently specified. Several studies emphasize abnormality rates, although definitions used to determine abnormal results vary. A number of studies address the influence of abnormal results on perioperative management, although in some cases the nature of the impact is imprecisely described or abnormalities considered positive would be expected to have had little to no significant influence on clinical management (eg, rib fractures, scarring and atelectasis, and slightly increased cardiothoracic ratio). Few reports focus on postoperative pulmonary complication as a primary outcome measure [3], although several discuss patient-related and procedure-related risk factors for postoperative complications. Several reports also highlight the role of the clinical history and physical examination in patient selection for preoperative chest radiography.

Review of available literature over the past 35 years reveals a lack of supportive evidence for the broad utilization of the routine preoperative chest radiograph. In 1978, the routine preoperative radiograph was reported to be of little therapeutic value as a baseline for future comparison [4]. The Royal College of Radiologists published the first major review of the preoperative chest radiograph in 1979 [5]. The chest radiograph did not influence either the decision to operate or the choice of anesthetic in 10,619 patients undergoing elective noncardiopulmonary surgery. The Royal College subsequently issued a statement that the practice was not justified [6]. Several reports have since highlighted the frequent demonstration of abnormalities on preoperative chest radiographs but a low impact of the abnormalities on clinical management, especially in patients without symptoms or a pertinent clinical history [7-11]. Multiple studies have also reported an ability to predict most clinically significant radiographic abnormalities from a reliable history and physical examination [7,10]. In a meta-analysis by Archer et al [7] on 21 studies from 1966–1992, only 1.3% of chest radiographic abnormalities would not have been identified from the history and physical examination. Some increased value in the chest radiograph was suggested in certain situations, such as an unreliable clinical evaluation and increased prevalence of pulmonary disease in a background population. A number of reports have also emphasized the greater likelihood of an abnormal chest radiograph in patients of advanced age [3,8,10,12-14] and a greater risk of major postoperative pulmonary

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complications in that population [12,15]. Boghosian and Mooradian [12] reported that abnormal chest radiographs did not predict postoperative complications in elderly patients but that patients of age >70 years had a greater frequency of major postoperative complications even when only high-risk patients were considered. They suggested that age should influence the decision to perform a routine preoperative chest radiograph and recommended chest radiographs for elderly patients regardless of history, particularly if >70 years of age. A multicenter study by Bouillot et al [8] reported that 23% of preoperative posteroanterior (PA) radiographs demonstrated abnormalities, which varied with age. In each of 4 risk groups, 56% of the abnormalities were chronic, with more than half in patients of age >65 years. The preoperative radiograph contributed to the diagnosis of postoperative complications in about 5% of cases.

In 1999, Silvestri et al [16] published a large prospective multicenter study of 6111 patients that investigated the impact on anesthetic management of routine preoperative chest radiographs performed on elective surgery patients based on an established protocol. Radiographs were abnormal in 18.3% of patients and influenced anesthesia in 5.1% of patients. In multivariate analysis, male gender, age >60 years, American Society of Anesthesiologists (ASA) class ≥ 3 , respiratory illness, and the presence of 2 or more coexisting diseases were significantly related to the probability of a useful preoperative radiograph. In 2005, Joo et al [13] published a systematic review of 14 manuscripts from 1966–2004 while taking into account the quality of evidence on screening preoperative chest radiographs. The diagnostic yield of the chest radiograph increased with age (3%–16% in age <50 years; 47%–61% in age >70 years) and risk factors (eg, cardiopulmonary disease and severe systemic illness), but most detected abnormalities were anticipated and chronic (eg, cardiomegaly and chronic obstructive pulmonary disease [COPD]). Postoperative pulmonary complications were similar in patients with (12.8%) and without (16%) preoperative radiographs. Chest radiographs impacted the management of 10% of patients, although an association could not be established between preoperative screening and a decrease in morbidity and mortality. Fair evidence supported the elimination of chest radiographs in asymptomatic patients of age <70 years, although there was insufficient evidence for or against the performance of routine chest radiographs in patients >70 years old. In a 2006 systematic review of literature from 1980–2005, Smetana et al [3] addressed preoperative pulmonary risk stratification before noncardiothoracic surgery. Good evidence was found for advanced age, ASA class 2 or higher, functional dependence, COPD, and congestive heart failure (CHF) as patient-related risk factors for postoperative pulmonary complications. Procedure-related risk increased with certain surgeries, such as aortic aneurysm repair; neurosurgery; and nonresective thoracic, abdominal, vascular, and head and neck surgeries, along with emergency and prolonged surgeries. The incremental value of the chest radiograph in estimating postoperative pulmonary complications was small, but a limited role was suggested for preoperative radiography in patients with known cardiopulmonary disease and patients of age >50 years scheduled for abdominal aortic aneurysm, thoracic, or upper abdominal surgery.

In the past several years, the preoperative chest radiograph has also been addressed in reports that have examined indications for multiple different preoperative tests. In 1997, Munro et al [17] published a systematic review of preoperative testing in apparently healthy patients. Eight studies allowed outcomes of routine preoperative chest radiographs to be distinguished from those of indicated chest radiographs. Findings on routine radiographs were reported as abnormal in 2.5%–37% of cases, resulting in a change in clinical management in only 0%–2.1%. Both yield of abnormalities and impact on patient management rose with age and poorer anesthesiology status. A review of routine preoperative laboratory testing by Smetana and Macpherson [14] in 2003 reported that a normal preoperative chest radiograph did not correlate with a substantial decrease in likelihood of a complication in a subset of studies from 1980–2000. Three percent of routine chest radiographs were abnormal and led to a modification of perioperative management. Fritsch et al [15] investigated the correlation of abnormal preoperative testing and medical history results with perioperative complications in 1363 elective surgery patients. Four hundred ten patients received chest radiographs according to individual physician practice, 32 of which (7.8%) were abnormal. Age, invasiveness of surgery, and medical history were determined to be better predictors of perioperative complications than were test results, and selective preoperative testing was recommended in elective surgery patients. Conclusions on obesity as a risk factor for postoperative complications have varied in the literature [3,18,19], as have recommendations regarding preoperative chest radiography. Ramaswamy et al [20] evaluated preoperative testing on severely obese patients (mean BMI, 50 kg/m²) undergoing gastric bypass surgery. Only 4% of preoperative chest radiographs demonstrated abnormalities (mild cardiomegaly, granuloma, and stable lung lesion), none of which required preoperative intervention. Chest radiographs were not recommended as a routine for these patients. In contrast, Poirier et al [21] have advocated that chest radiographs be part of preoperative testing on all severely obese patients (BMI ≥ 40 kg/m²).

Few studies have addressed the use of routine chest radiography before interventional and vascular procedures. Murphy et al [22] surveyed interventional radiologists on the uses of several routine tests, including chest radiographs, and reported overuse of preprocedural testing. Selective testing was recommended based on clinical suspicion. Malone et al [23] published an evaluation of 75 patients who received routine PA and lateral chest radiographs both before and after extracorporeal electromagnetically generated shock-wave lithotripsy and concluded that chest radiography was not warranted. Grier et al [24] reported that routine chest radiography was not necessary before peripheral or coronary angiography in the absence of specific clinical indications. In their 240 patients, no angiogram was postponed or canceled because of abnormalities detected on routine chest radiographs. Cardiac enlargement and heart failure constituted the majority of abnormalities. Goldstein [25] assessed the value of routine chest radiographs obtained in 113 patients under consideration for reperfusion therapy during emergent evaluation of stroke symptoms. Seventy percent of radiographs were normal and 26% demonstrated incidental findings. Potentially relevant findings were found on 3.8% of routine radiographs, but none affected clinical management. Chest radiographs without specific indication were not recommended as part of emergent stroke evaluation before intervention.

Routine Hospital Admission Chest Radiographs

Literature on the use of chest radiographs to evaluate for occult abnormalities in asymptomatic hospital admissions is limited and has primarily addressed specific populations. In 1985, Gupta et al [26] found little or no clinical indication for routine chest radiography in 35%–50% of 1000 geriatric admissions. Among indicated studies, 5.5% demonstrated an abnormality, which was significant in <1% of cases. Among unindicated studies, 17% were in patients with known chronic cardiac or pulmonary disease, and radiographic findings did not impact management. Hubbell et al [27] studied 491 Veterans Administration internal medicine hospital admissions, 294 of whom received routine admission anterior-posterior chest radiographs. Of 36% with abnormalities, 29% were chronic and stable and 7% were new. Chest radiographs prompted treatment modification in only 4% of cases, and it was anticipated that necessary treatment would likely have been omitted in only 1 patient (0.3%) had the chest radiograph not been obtained. The influence of the radiograph was small even when the prevalence of cardiopulmonary disease was high. White et al [28] prospectively studied the impact of routine PA and lateral chest radiographs on 188 medical admissions from an emergency department. Abnormalities were more common in subpopulations at high risk for treatment-altering abnormalities (age ≥ 65 years, smoking history, altered mental status, and HIV positivity) than in low-risk groups (82% versus 61%). Treatment was altered by unsuspected abnormalities in 3% of patients, each of whom was a member of a high risk subpopulation.

In 2002, Gomez-Gil et al [29] found routine chest radiographs to be normal in 81.5% of 200 patients admitted to an acute psychiatric ward. Relevant abnormalities present in 5% of cases were clinically known and did not alter management. Possible benefits of chest radiography were suggested in the elderly and in cases of cognitive alteration or alcohol or drug abuse, and selective ordering was recommended based on the clinical history and physical examination. In 2010, Malnick et al [30] published on 675 consecutive medicine patients who received mandated admission chest radiographs. A significant yield was found only in cases where the physical examination was abnormal or there was a clear clinical indication for ordering the radiograph. Excluding these patients, the routine radiograph contributed to management in only 3.6% of cases. Verma et al [31] evaluated chest radiographs obtained on 229 hospital medical admissions, 129 of which were routine. Most abnormalities found in 43.4% of cases were chronic, stable, and previously known. Management was altered in only 3.87% of cases and included the diagnoses of CHF and pneumonia (age >65 years) with altered mental status. There was a small impact on patient care from routine admission chest radiographs, including if obtained on patients with preexisting but stable cardiopulmonary disease. Admission chest radiographs were recommended only on patients with clinical findings of cardiopulmonary disease or elderly patients unable to provide an accurate history or undergo a reliable physical examination.

Routine Chest Radiographs in Asymptomatic Outpatients

Outpatient chest radiographs were once frequently performed as part of a periodic health examination, pre-employment physical, or multiphase screening program to evaluate for occult pathology, such as tuberculosis and obstructive pulmonary disease. Chest radiographs are no longer advocated in such cases without medical indication [32,33], nor are they recommended to screen for lung cancer [34]. The performance of chest radiographs on asymptomatic primary care patients was addressed in a 2004 paper by Tigges et al [35], in which 1282 (34%) of 3812 chest radiographs had been ordered as routine or screening studies. The diagnostic yield of the chest radiograph was low. Of 15 abnormalities considered major (12 nodules, a lung mass, a lobar atelectasis,

and a mediastinal adenopathy), all were in patients aged 40 years or older, 14 were false positives, and none required treatment. Oken et al [36] reported on the effect on mortality of lung cancer screening performed by chest radiography on participants in the Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening Trial between 1993 and 2001. A subset analysis was included on PLCO participants who met eligibility for the National Lung Screening Trial. Of 154,901 participants aged 55–74 years, 77,445 received annual screening for 4 years and 77,456 received usual care. Annual screening by chest radiography did not reduce lung cancer mortality.

A chest radiograph is sometimes performed as part of the evaluation of an asymptomatic patient with uncomplicated hypertension [37]. Kristensen [38] reported most radiographic abnormalities in hypertensive patients to be minor (prior granulomatous disease, tortuous aorta, or fibrosis) and without management value. The chest radiograph has been advocated to assess for certain abnormalities, such as aortic coarctation, cardiogenic edema, aortic valvular calcification, and smoking-related lung disease, that may not be conspicuous on examination but may impact hypertensive workup and treatment [39-42]. Varying degrees of success have been reported in the use of the chest radiograph to evaluate for cardiomegaly and to gauge left ventricular hypertrophy (LVH), which is a marker of poor prognosis [38,40,43-46]. In 1982, Hartford et al [47] reported cardiomegaly in 17% of patients with moderate to severe hypertension, compared to 7% of patients with mild hypertension. In 2004, Rayner et al [40] published a study of 72 hypertensive and 77 age- and sex-matched normotensive patients. Cardiothoracic ratio and aortic knob enlargement were both reported as useful predictors of target organ damage. Cardiothoracic ratio was an independent predictor of LVH. It was suggested that in conjunction with an electrocardiogram, the chest radiograph may provide important information on the presence of LVH. In 2004 Tsakiris et al [42] reported a higher prevalence of aortic arch calcification on chest radiographs in hypertensive patients than in the general population and age and gender (female) dependence. Increased left ventricular mass on echocardiography and aortic calcification on chest radiography were concurrent occurrences influenced by hypertension and age.

Summary of Recommendations

- Available evidence does not support the broad performance of routine chest radiography. Despite the frequent demonstration of abnormalities, routine chest radiographs uncommonly add clinically significant information that would not have been predicted by a reliable history and physical examination.
- In the case of the preoperative chest radiograph, evidence suggests that increased management value may accompany advanced patient age (especially >70 years) and certain other patient- and procedure-related risk factors (eg, history of cardiopulmonary disease, unreliable history and physical examination, high-risk surgery); however, the ability of a preoperative chest radiograph to forecast postoperative pulmonary complications is low.
- The decision to perform a chest radiograph in the preoperative, preintervention, hospital admission, and asymptomatic outpatient settings should principally derive from a need to investigate a clinical suspicion for acute or unstable chronic cardiopulmonary disease that could influence patient care. Selective ordering is recommended, including in patients of advanced age or otherwise at increased risk.
- Routine chest radiography is not definitively indicated in uncomplicated hypertension. There may be value in patients with moderate to severe hypertension and potential aortic coarctation or cardiogenic edema, in addition to patients with overt cardiopulmonary signs or symptoms.
- The anticipated value from ordering a chest radiograph should be weighed against adverse effects, including radiation exposure, procedural delay, anxiety, and potential morbidity from the investigation of incidental findings.

Summary of Evidence

Of the 47 references cited in the *ACR Appropriateness Criteria® Routine Chest Radiography* document, 45 are categorized as diagnostic references including 1 well designed study, 2 good quality studies, and 4 quality studies that may have design limitations. Additionally, 1 reference is categorized as a therapeutic reference. There are 39 references that may not be useful as primary evidence. There is 1 reference that is a meta-analysis study.

The 47 references cited in the *ACR Appropriateness Criteria® Routine Chest Radiography* document were published from 1965-2014.

While there are references that report on studies with design limitations, 3 well designed or good quality studies provide good evidence.

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, both because of 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 to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

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

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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.