

## American College of Radiology ACR Appropriateness Criteria®

**Clinical Condition:** Routine Chest Radiograph

**Variant 1:** Monitoring stable patient.

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray chest portable routine admission	9	Not for coronary artery bypass graft. Not for acute upper gastrointestinal bleeding.	☼
X-ray chest portable clinical indications only	8	Clinical worsening only.	☼
X-ray chest portable routine monitoring	2		☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 2:** Respiratory failure. Patient receiving mechanical ventilation.

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray chest portable daily	9		☼
X-ray chest portable clinical indications only	9		☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 3:** Compromised respiratory function. Patient with endotracheal tubes.

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray chest portable after catheter/tube insertion	9		☼
X-ray chest portable clinical indications only	9		☼
X-ray chest portable follow-up	2		☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 4:** Central venous pressure catheter (CVP) insertion.

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray chest portable after catheter/tube insertion	9		☼
X-ray chest portable clinical indications only	8		☼
X-ray chest portable follow-up	2		☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:****Routine Chest Radiograph****Variant 5:****Cardiopulmonary compromise. Swan-Ganz catheter insertion.**

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray chest portable after catheter/tube insertion	9		☼
X-ray chest portable clinical indications only	8		☼
X-ray chest portable follow-up	2		☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 6:****Potential cardiopulmonary compromise. Nasogastric (NG) tube insertion.**

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray chest portable after catheter/tube insertion	9	Feeding NG tube.	☼
X-ray chest portable after catheter/tube insertion	6	Nonfeeding NG tube.	☼
X-ray chest portable follow-up	2		☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 7:****Respiratory compromise. Chest tube insertion.**

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray chest portable after catheter/tube insertion	8		☼
X-ray chest portable clinical indications only	8		☼
X-ray chest portable follow-up	2		☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

# ROUTINE CHEST RADIOGRAPH

Expert Panel on Thoracic Imaging: Judith K. Amorosa, MD<sup>1</sup>; Mark Paul Bramwit, MD<sup>2</sup>; Arfa R. Khan, MD<sup>3</sup>; Tan-Lucien Mohammed, MD<sup>4</sup>; Poonam V. Batra, MD<sup>5</sup>; Debra Sue Dyer, MD<sup>6</sup>; Jud W. Gurney, MD<sup>7</sup>; Jean Jeudy, MD<sup>8</sup>; Larry Kaiser, MD<sup>9</sup>; Heber MacMahon, MB, BCh<sup>10</sup>; Suhail Raof, MBBS<sup>11</sup>; Kay H. Vydareny, MD.<sup>12</sup>

## **Summary of Literature Review**

### **Portable Radiographs in the ICU Setting**

Portable radiographs can be categorized as:

1. Daily or routine radiographs for patient monitoring.
2. Radiographs obtained after specific procedures.
3. Radiographs documenting the presence or course of disease.

This narrative concerns daily routine radiographs only and does not include postprocedural or postsurgical radiographs. Studies that involved large volumes of chest radiographs (CXR) (>200) were reviewed. The most recent two studies evaluated the clinically relevant use of daily routine versus nonroutine clinically indicated CXRs. A large study by Graat et al [1] prospectively evaluated the clinical value of 2,457 routine CXRs in a combined surgical/medical intensive care unit (SICU/MICU). In their study, 5.8% of daily routine CXRs showed new or unexpected findings; but only 2.2% warranted a change in therapy. No difference was found between the medical and surgical patients. A randomized control study of MICU patients by Krivopal et al [2] prospectively divided them into those who received daily routine CXRs and those who only received nonroutine (clinically indicated) CXRs. They found a greater percentage of radiographs with significant findings (requiring intervention) in the nonroutine group (26.5%) than in the routine group (13.3%). Significant interventions included diuresis, antibiotic administration, or invasive procedures. The nonroutine group also received significantly fewer radiographs per person than the routine group (4.4 vs 6.8).

There was no significant difference in outcome between the groups in length of intubation, ICU stay, hospital stay, or mortality.

A recent prospective observational study [3] analyzed 1,780 routine CXRs in 559 hospital ICU admissions. It concluded that the diagnostic and therapeutic value of routine CXR is low, and the authors recommended abandoning routine CXRs in the ICU.

Older studies reviewed only daily radiographs in ICU patients without comparison to the outcome of those without routine radiographs. The yield of routine radiographs was overall higher, especially in MICU patients and in those who were intubated. If one uses a broad definition of radiographic value such as “important or unexpected findings,” the range in results was large, from 3% to 60%. Studies by Brainsky et al [4] and Marik et al [5] reported 20% and 37% changes in management, respectively, from routine portable CXRs obtained in the MICU. Patients who were intubated were the most affected. Hall et al [6] reported the lowest rate of significant abnormal CXR findings at 3% of all radiographs in 18% of the MICU patients. They still recommended daily routine studies on all critically ill patients. In a study by Strain et al [7] a high yield was found in MICU patients who had acute cardiopulmonary disease, but the yield was very low in patients with stable cardiac disease (usually myocardial infarction) and in ICU patients who had extrathoracic disease only.

For cardiothoracic ICU patients, two prospective nonrandomized studies [8,9] showed a low incidence of significant findings on routine radiographs (4.5% in both studies) and consequently a minimal impact on patient management. The results support the recommendation to obtain CXRs in cardiothoracic ICU for clinical findings and not for routine follow-up.

### *Recommendation*

Routine daily radiographs are indicated for patients with acute cardiopulmonary problems. In stable patients admitted for cardiac monitoring, or in stable patients admitted for extrathoracic disease only, an initial admission radiograph is recommended, with follow-up radiographs obtained only for specific clinical indications.

### **Endotracheal Tubes**

There are nine studies described in the literature since 1980 [5,7,9-15] that evaluate the significance of the chest radiograph in assessing endotracheal tube placement following insertion. In five of them, between 12% and 15% of patients had malpositioned endotracheal tubes, many of which required repositioning. Two studies found 28% and 46% of tubes malpositioned upon insertion, and the single dissenting paper found 2% malpositioned. Two studies compared radiographs with physical examination [10,16]. In both studies, physical examination predicted malpositioned tubes in 3% of patients, whereas the radiographs showed malpositioning in 14% of patients in

<sup>1</sup>Principal Author, Robert Wood Johnson Medical School, New Brunswick, New Jersey.

<sup>2</sup>Research Author, Robert Wood Johnson Medical School, New Brunswick, New Jersey.

<sup>3</sup>Panel Chair, Long Island Jewish Medical Center, New Hyde Park, New York.

<sup>4</sup>Panel Vice-chair, Cleveland Clinic Foundation, Cleveland, Ohio.

<sup>5</sup>David Geffen School of Medicine, Los Angeles, California.

<sup>6</sup>National Jewish Health, Denver, Colorado.

<sup>7</sup>University of Nebraska, Omaha, Nebraska.

<sup>8</sup>University of Maryland Medical Center, Baltimore, Maryland.

<sup>9</sup>University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, Society of Thoracic Surgeons.

<sup>10</sup>University of Chicago Hospital, Chicago, Illinois.

<sup>11</sup>New York Methodist Hospital, Brooklyn, New York, American College of Chest Physicians.

<sup>12</sup>Emory University School of Medicine, Atlanta, Georgia.

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.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

one study and 28% in the other. Kollef et al [17] found that the vast majority of malpositioned tubes were discovered in the first 3 days.

#### *Recommendation*

Very few malpositioned tubes are detected by physical examination. Radiographs immediately postintubation are indicated to insure proper positioning.

#### **CVP Catheters**

Eight studies were reviewed regarding central venous pressure (CVP) catheters [7,10-15,17]. The vast majority came to the same conclusion. Approximately 10% of the CXRs demonstrated malpositioned catheters. Pneumothoraces were present in only a small percentage of patients. Gray et al [10] separated jugular and subclavian catheters. Complications were twice as common with subclavian catheters (17% vs 8%), although unsuspected complications were infrequent.

#### *Recommendation*

A CXR after insertion of a CVP catheter is recommended to demonstrate proper placement and detect any complications. Beyond the initial insertion, follow-up radiographs have a low yield for revealing complications. Follow-up radiographs are suggested only when complications are suspected clinically.

#### **Swanz-Ganz Catheters**

Previously mentioned studies incorporated the position and potential complications of Swan-Ganz catheter placements on CXRs obtained immediately postprocedure. The majority of complications, which occur in approximately 10% of catheter insertions, are minor and require catheter repositioning [10,11,13,18]. The pneumothorax rate was approximately 2% [11,18].

#### *Recommendation*

Radiographs are suggested after catheter insertion. Once pneumothorax has been excluded and proper positioning has been assured, follow-up radiographs are not required except for specific clinical indications.

#### **Nasogastric Tubes**

There are no large prospective studies that consider the utility of obtaining CXR immediately after the insertion of a nasogastric suction tube or a small-bore feeding tube. Radiographs revealed important tube malpositioning in 1% of cases [7,11,13]. Other complications have also been reported [19-22]. Clearly, a patient with a functioning nasogastric tube that has already been documented to be in satisfactory position needs no imaging unless a clinical problem arises.

#### *Recommendation*

Based on limited evidence, small-bore feeding tubes may, in a small but significant number of patients, be inadvertently placed in the lungs. This error is not always detected clinically and may lead to injection of feeding material into the lung or tube penetration of the pleura, with subsequent pneumothorax. A CXR is warranted after initial nasogastric tube insertion and before the first

feeding. Beyond the initial radiograph, follow-up radiographs are not required for managing stable tubes.

#### **Chest Tubes**

Few studies have been performed to evaluate the efficacy of the initial CXR after the insertion of a chest tube. The three available studies show that approximately 10% of tubes are malpositioned [7,12,15]. Many of the radiographic abnormalities detected are minor and do not result in changes of tube positions.

#### *Recommendation*

After insertion of a chest tube, a CXR is recommended to show the position of the tube, any success in drainage, and possible complications from insertion. Beyond this point, evaluation of tube position and function is warranted based on management of the pleural space and clinical indications.

#### **Acknowledgement**

The authors wish to thank Payam G. Torrei, MD, and Timothy Bing-Tee Chen, MD, of the Robert Wood Johnson Medical School for their contributions to this document.

#### **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
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 NS (not specified).

### Supporting Document(s)

- [ACR Appropriateness Criteria® Overview](#)
- [Procedure Contrast Information](#)
- [Evidence Table](#)

### References

1. Graat ME, Choi G, Wolthuis EK, et al. The clinical value of daily routine chest radiographs in a mixed medical-surgical intensive care unit is low. *Crit Care* 2006; 10(1):R11.
2. Krivopal M, Shlobin OA, Schwartzstein RM. Utility of daily routine portable chest radiographs in mechanically ventilated patients in the medical ICU. *Chest* 2003; 123(5):1607-1614.
3. Hendrikse KA, Gratama JW, Hove W, Rommes JH, Schultz MJ, Spronk PE. Low value of routine chest radiographs in a mixed medical-surgical ICU. *Chest* 2007; 132(3):823-828.
4. Brainsky A, Fletcher RH, Glick HA, Lanken PN, Williams SV, Kundel HL. Routine portable chest radiographs in the medical intensive care unit: effects and costs. *Crit Care Med* 1997; 25(5):801-805.
5. Marik PE, Janower ML. The impact of routine chest radiography on ICU management decisions: an observational study. *Am J Crit Care* 1997; 6(2):95-98.
6. Hall JB, White SR, Karrison T. Efficacy of daily routine chest radiographs in intubated, mechanically ventilated patients. *Crit Care Med* 1991; 19(5):689-693.

7. Strain DS, Kinasewitz GT, Vereen LE, George RB. Value of routine daily chest x-rays in the medical intensive care unit. *Crit Care Med* 1985; 13(7):534-536.
8. Graham RJ, Meziane MA, Rice TW, et al. Postoperative portable chest radiographs: optimum use in thoracic surgery. *J Thorac Cardiovasc Surg* 1998; 115(1):45-50; discussion 50-42.
9. O'Brien W, Karski JM, Cheng D, Carroll-Munro J, Peniston C, Sandler A. Routine chest roentgenography on admission to intensive care unit after heart operations: is it of any value? *J Thorac Cardiovasc Surg* 1997; 113(1):130-133.
10. Gray P, Sullivan G, Ostzyzniuk P, McEwen TA, Rigby M, Roberts DE. Value of postprocedural chest radiographs in the adult intensive care unit. *Crit Care Med* 1992; 20(11):1513-1518.
11. Silverstein DS, Livingston DH, Elcavage J, Kovar L, Kelly KM. The utility of routine daily chest radiography in the surgical intensive care unit. *J Trauma* 1993; 35(4):643-646.
12. Henschke CI, Pasternack GS, Schroeder S, Hart KK, Herman PG. Bedside chest radiography: diagnostic efficacy. *Radiology* 1983; 149(1):23-26.
13. Horst HM, Fagan B, Beute GH. Chest radiographs in surgical intensive care patients: a valuable "routine". *Henry Ford Hosp Med J* 1986; 34(2):84-86.
14. Brunel W, Coleman DL, Schwartz DE, Peper E, Cohen NH. Assessment of routine chest roentgenograms and the physical examination to confirm endotracheal tube position. *Chest* 1989; 96(5):1043-1045.
15. Bekemeyer WB, Crapo RO, Calhoun S, Cannon CY, Clayton PD. Efficacy of chest radiography in a respiratory intensive care unit. A prospective study. *Chest* 1985; 88(5):691-696.
16. Bhagwanjee S, Muckart DJ. Routine daily chest radiography is not indicated for ventilated patients in a surgical ICU. *Intensive Care Med* 1996; 22(12):1335-1338.
17. Kollef MH, Legare EJ, Damiano M. Endotracheal tube misplacement: incidence, risk factors, and impact of a quality improvement program. *South Med J* 1994; 87(2):248-254.
18. Sise MJ, Hollingsworth P, Brimm JE, Peters RM, Virgilio RW, Shackford SR. Complications of the flow-directed pulmonary artery catheter: A prospective analysis in 219 patients. *Crit Care Med* 1981; 9(4):315-318.
19. Kassner EG, Baumstark A, Balsam D, Haller JO. Passage of feeding catheters into the pleural space: a radiographic sign of trauma to the pharynx and esophagus in the newborn. *AJR Am J Roentgenol* 1977; 128(1):19-22.
20. Hand RW, Kempster M, Levy JH, Rogol PR, Spirn P. Inadvertent transbronchial insertion of narrow-bore feeding tubes into the pleural space. *Jama* 1984; 251(18):2396-2397.
21. Balogh GJ, Adler SJ, VanderWoude J, Glazer HS, Roper C, Weyman PJ. Pneumothorax as a complication of feeding tube placement. *AJR Am J Roentgenol* 1983; 141(6):1275-1277.
22. Dorsey JS, Cogordan J. Nasotracheal intubation and pulmonary parenchymal perforation. An unusual complication of naso-enteral feeding with small-diameter feeding tubes. *Chest* 1985; 87(1):131-132.

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.