Complete Summary

GUIDELINE TITLE

Congestive heart failure.

BIBLIOGRAPHIC SOURCE(S)

White CS, Davis SD, Aquino SL, Batra PV, Goodman PC, Haramati LB, Khan A, Leung AN, McLoud TC, Rosado de Christenson ML, Rozenshtein A, Kaiser L, Raoof S, Expert Panel on Thoracic Imaging. Congestive heart failure. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 4 p. [22 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: American College of Radiology (ACR), Expert Panel on Thoracic Imaging. Congestive heart failure. Reston (VA): American College of Radiology (ACR); 2003. 4 p. (ACR appropriateness criteria).

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

COMPLETE SUMMARY CONTENT

SCOPE
METHODOLOGY - including Rating Scheme and Cost Analysis
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SCOPE

DISEASE/CONDITION(S)

Congestive heart failure

GUIDELINE CATEGORY

Diagnosis
Evaluation

CLINICAL SPECIALTY

Cardiology
Internal Medicine
Pulmonary Medicine
Radiology

INTENDED USERS

Health Plans
Hospitals
Managed Care Organizations
Physicians
Utilization Management

GUIDELINE OBJECTIVE(S)

To provide appropriate recommendations for the use of chest radiography for the evaluation of patients with known or suspected congestive heart failure

TARGET POPULATION

Patients with known or suspected congestive heart failure

INTERVENTIONS AND PRACTICES CONSIDERED

Diagnosis/Evaluation

1. X-ray, chest
2. Computed tomography (CT), chest
3. Magnetic resonance imaging (MRI), chest

MAJOR OUTCOMES CONSIDERED

Utility of radiologic examinations in differential diagnosis

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline developer performed literature searches of peer-reviewed medical journals, and the major applicable articles were identified and collected.

NUMBER OF SOURCE DOCUMENTS

The total number of source documents identified as the result of the literature search is not known.

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Not Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not stated

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed for reaching agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table and narrative as developed by the topic leader(s). Questionnaires are completed by participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1-9, indicating the most to the least appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty percent agreement is considered a consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by the Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of

each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

ACR Appropriateness Criteria®

Clinical Condition: Congestive Heart Failure

Variant 1: New CHF, suspected based on symptoms and physical examination.

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, chest	9	
CT, chest	2	CHF is readily diagnosed on CT obtained for other indications.
MRI, chest	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Previous CHF, currently stable.

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, chest	4	
CT, chest	2	CHF is readily diagnosed on CT obtained for other indications.
MRI, chest	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Previous CHF, new-onset signs and symptoms.

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, chest	9	
CT, chest	2	CHF is readily diagnosed on CT obtained for other indications.
MRI, chest	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

A variety of definitions exist as to what constitutes CHF. An accepted physiologic definition is the failure of the heart to pump sufficient blood to supply the needs of the metabolizing tissues. Either systolic or diastolic dysfunction can lead to CHF. It is most commonly due to ischemic heart disease. Other causes include valvular heart disease, cardiomyopathies, hypertension, and left-to-right shunts. Clinically, heart failure is recognized by the occurrence of signs and symptoms in combination with objective evidence of cardiac dysfunction. Signs and symptoms of heart failure include dyspnea on exertion or orthopnea, elevation of the jugular venous pressure, and pitting edema of the ankles. A third heart sound is often heard, but this finding is subject to substantial interobserver variability. Objective methods of evaluating cardiac function include chest radiography, nuclear cardiology, echocardiography, cardiac catheterization, CT, MRI, electrocardiography, and exercise testing. This document will deal predominately with the usefulness of the chest radiograph for evaluating patients with known or

suspected CHF. It is important to note that patients with diseases other than CHF may have one or several of its signs and symptoms.

Chest Radiography

The chest radiograph is a useful technique to screen patients who exhibit the signs and symptoms of CHF. Several typical findings of CHF occur in patients who undergo radiography in an erect position. At an early stage, the normally gravity-dependent blood flow may become equalized, with upper and lower lung vessels of similar caliber. Later, upward diversion of blood flow may be present such that the upper lobe vessels are larger than those in the lower lungs.

If pulmonary wedge pressure is higher, signs of interstitial pulmonary edema may be seen. These include thickened interlobular septa, perihilar and perivascular haziness, peribronchial cuffing and increased artery-bronchus (A-B) ratio.

Several studies have assessed the relationship between findings of pulmonary venous hypertension and measures of left ventricular function. One study assessed the value of chest radiography to predict abnormal left ventricular function following acute myocardial infarction. The sensitivity of radiographic pulmonary venous congestion for depressed ejection fraction was 52%; specificity was 74%. Another study evaluated 104 patients with varying degrees of left ventricular dysfunction. The authors reported that, while most patients with elevated left ventricular end diastolic pressure had radiographic evidence of CHF, 38% did not. Several other studies have all reported a significant but imperfect correlation between radiographic findings of pulmonary venous hypertension and left ventricular dysfunction.

The cardiac silhouette is variably enlarged in CHF. The size of the heart has only a weak, clinically insignificant correlation with severity of CHF as measured by ejection fraction. Patients with an initial myocardial infarction who have severe cardiac dysfunction may have a nearly normal cardiac size because the heart may not dilate acutely. One group of researchers investigated 82 patients with CHF and found that the cardiothoracic ratio correlated best ($r = 0.70$) with the degree of elevation of capillary wedge pressure. In another study, enlargement of cardiothoracic ratio (threshold = 0.5) had a sensitivity of 47% for detecting an abnormal ejection fraction (≥ 0.51). A third study assessed the utility of cardiothoracic ratio to estimate ejection fraction in 7,476 patients with left-sided heart failure and found only a limited correlation ($r = 0.18$).

An enlarged vascular pedicle is also often present in CHF. The vascular pedicle is defined as the sum of the distance of the right mediastinum at the level of the azygos arch to the midline and base of left subclavian artery to midline. This method of evaluating fluid status has been advocated by two separate sets of researchers. It does thus reflect fluid status in both the arterial and venous system. However, variability in mediastinal widths between patients mitigates some advantages of this technique. In practice, the use of the vascular pedicle is best applied to assessment of volume status of an individual patient, provided changes in patient positioning, depth of inspiration, and tube position are taken into account. Pleural effusions are common in patients with CHF. Other radiographic findings that may aid in the diagnosis of CHF are a relative increase in pulmonary artery–bronchus ratio in the upper as compared with lower lung

zones and thickening of the posterior wall of the bronchus intermedius on the lateral radiograph.

In patients who are unable to cooperate for an erect posteroanterior and lateral radiograph, particularly those in the intensive care unit (ICU), portable radiography may be necessary. Portable radiography is most often obtained with the patient in a semi-erect or supine position, which alters the appearance of radiographic findings of CHF. In a supine position, equalization of vasculature or flow inversion is physiologically normal. Thus, recognition of CHF depends to a greater extent on the presence of pulmonary edema, which occurs only in more severe cases. In the ICU, airspace edema caused by CHF is often difficult to distinguish from noncardiogenic edema and diffuse pulmonary infection.

Pleural effusions are also more difficult to recognize in the recumbent patient. Free pleural effusions layer in the posterior pleural cavity, creating a homogeneous opacity that may show a gradient of opacity from a caudal to cephalic direction, depending on the degree of patient recumbency. Bronchovascular markings are often visible through the hazy opacity. The presence of effusion can be confirmed by obtaining a lateral decubitus view.

The chest radiograph may occasionally show an atypical pattern in CHF. The best-characterized situation is in patients who develop acute mitral regurgitation, in which a strikingly asymmetric edema pattern occurs with predominant opacity in the right upper lobe. This pattern is caused by the flow vector in mitral regurgitation, which is usually directed toward the right superior pulmonary vein. In patients who have chronic lung disease due to parenchymal fibrosis or emphysema, the appearance of CHF can be atypical. With emphysema, the chest radiograph may show an accentuation of preexisting interstitial lines rather than airspace edema because of alveolar destruction in emphysematous areas.

The chest radiograph is also useful for diagnosing diseases other than CHF in patients with dyspnea. The radiographic distinction of CHF from increased permeability edema, of which the adult respiratory distress syndrome is the prototype, may be difficult. Findings that favor CHF are an enlarged cardiac silhouette, Kerley lines, and pleural effusions. Lobar pneumonia and abscess, pulmonary infarction, lung masses or nodules, and focal pleural disease are usually readily distinguishable from CHF.

Computed Tomography

The role of CT scanning in patients is increasing due to the development of multidetector CT with better spatial and temporal resolution and electrocardiogram (ECG) gating. These advances permit assessment of left ventricular function, including stroke volume and ejection fraction. Short and long axis imaging obtained throughout the cardiac cycle allows determination of wall motion abnormalities, which may be an ischemic cause for the heart failure. Moreover, stenotic coronary artery lesions can be delineated using coronary computed tomography angiography (CTA). Disadvantages include the increased radiation dose associated with retrospective ECG-gating and nephrotoxicity due to intravenous contrast administration. Despite much early enthusiasm, there are as yet few studies documenting the value of cardiac CTA in assessing CHF. Thus, the role of cardiac CT as compared to nuclear cardiology is in evolution.

A second clinical scenario is CT scanning that is obtained for other indications that may show evidence of CHF, and thus recognition of findings in this entity is important. In CHF, animal studies have shown an increase in arterial and venous size and increased parenchymal opacification. In patients, gravity-dependent flow inversion causes enlargement of nondependent vessels (anterior vessels in supine patients). Interstitial edema produces thickening of interlobular septa and the peribronchovascular and subpleural interstitia. In patients with airspace edema, ground glass opacity is evident on standard and high-resolution CT. Pleural and pericardial effusions are more apparent and are easier to quantify on CT than on chest radiography.

Magnetic Resonance Imaging

MRI provides a large quantity of morphologic and physiologic information in the evaluation of the heart. Wall thickness and cavity size are easily measured. Cine MRI permits assessment of cardiac function, increased ejection fraction, and wall motion abnormalities. Recent work highlights the value of MRI perfusion viability imaging. In particular, recent investigation suggests that ischemic and nonischemic causes of cardiomyopathy can be distinguished by MRI, allowing appropriate selection of patients who may benefit from coronary revascularization. Despite its considerable promise, MRI has yet to be widely adopted for this role in clinical practice.

Summary

The various studies on the utility of chest radiography for CHF draw conclusions that are inconsistent and even contradictory. Nevertheless, the preponderance of data shows that most patients with CHF have radiographic abnormalities that may suggest the diagnosis. Thus use of chest radiography as part of the initial assessment of patients with suspected CHF seems appropriate. Similarly, in patients with known CHF whose clinical picture deteriorates from baseline, the data suggest that chest radiography is beneficial. Both CT and MRI may ultimately prove valuable to evaluate CHF, but should be regarded as technologies in evolution accompanying more established methods to evaluate cardiac status.

Abbreviations

- CHF, congestive heart failure
- CT, computed tomography
- MRI, magnetic resonance imaging

CLINICAL ALGORITHM(S)

Algorithms were not developed from criteria guidelines.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The recommendations are based on analysis of the current literature and expert panel consensus.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Selection of appropriate radiologic imaging procedures for evaluation of patients with known or suspected congestive heart failure

POTENTIAL HARMS

Disadvantages of computed tomography (CT) include the increased radiation dose associated with retrospective electrocardiogram (ECG)-gating and nephrotoxicity due to intravenous contrast administration.

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

An American College of Radiology (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 exams 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 United States Food and Drug Administration (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.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Living with Illness

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

White CS, Davis SD, Aquino SL, Batra PV, Goodman PC, Haramati LB, Khan A, Leung AN, McLoud TC, Rosado de Christenson ML, Rozenshtein A, Kaiser L, Raoof S, Expert Panel on Thoracic Imaging. Congestive heart failure. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 4 p. [22 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

2003 (revised 2006)

GUIDELINE DEVELOPER(S)

American College of Radiology - Medical Specialty Society

SOURCE(S) OF FUNDING

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

GUIDELINE COMMITTEE

Committee on Appropriateness Criteria, Expert Panel on Thoracic Imaging

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Panel Members: Charles S. White, MD; Sheila D. Davis, MD; Suzanne L. Aquino, MD; Poonam V. Batra MD; Philip C. Goodman, MD; Linda B. Haramati, MD; Arfa Khan, MD; Ann N. Leung, MD; Theresa C. McLoud, MD; Melissa L. Rosado de Christenson, MD; Anna Rozenshtein, MD; Larry R. Kaiser, MD; Suhail Raoof, MBBS

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

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GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

ACR Appropriateness Criteria® *Anytime*, *Anywhere*™ (PDA application). Available from the ACR Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

PATIENT RESOURCES

None available

NGC STATUS

This NGC summary was completed by ECRI on November 12, 2004. The information was verified by the guideline developer on December 21, 2004. This NGC summary was updated by ECRI on August 17, 2006.

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