Prevalence of Negative Chest Radiography Results in the Emergency Department Patient With Decompensated Heart Failure

Sean P. Collins, MD*
Christopher J. Lindsell, PhD
Alan B. Storrow, MD
William T. Abraham, MD
On behalf of the ADHERE Scientific Advisory Committee, Investigators and Study Group*

From the University of Cincinnati, Department of Emergency Medicine (Collins, Storrow) and the Institute for the Study of Health (Lindsell), Cincinnati, OH; and the Division of Cardiology, The Ohio State University, Columbus, OH (Abraham).

Study objective: Although chest radiography is quick and inexpensive, previous research suggests that it is often misleading in emergency department (ED) patients with decompensated heart failure, resulting in misdiagnosis and inappropriate treatment. This study determines the rate of negative chest radiography results in patients found to have disease and the potential contribution of negative findings to a diagnosis discordant with heart failure by an emergency physician.

Methods: We used data from the Acute Decompensated Heart Failure National Registry (ADHERE), a registry of patients with a primary hospital discharge diagnosis of heart failure. We compared initial ED admitting diagnosis to the criterion standard of a hospital discharge diagnosis of heart failure and related these to radiographic findings of heart failure (interstitial edema, pulmonary edema, or vascular congestion, as determined by a staff radiologist) for patients first treated in the ED. The proportion of patients with a non–heart failure ED diagnosis and the diagnostic sensitivity of radiographic findings of heart failure are calculated.

Results: There were 85,376 patients with chest radiograph results and an ED admitting diagnosis. Overall, there were 15,937 patients with no signs of congestion on ED chest radiography, giving a negative rate of 18.7% (95% confidence interval [CI] 18.4% to 18.9%). The proportion of patients with an ED non–heart failure admitting diagnosis was higher in patients with a negative chest radiograph result (23.3%; 95% CI 22.6% to 23.9%) than in patients with a positive chest radiograph result (13.0%; 95% CI 12.7% to 13.2%).

Conclusion: Approximately 1 of every 5 patients admitted from the ED with acute decompensated heart failure had no signs of congestion on chest radiography. Patients lacking signs of congestion on ED chest radiography were more likely to have an ED non–heart failure diagnosis than patients with signs of congestion. Clinicians should not rule out heart failure in patients with no radiographic signs of congestion. [Ann Emerg Med. 2006;47:13-18.]

0196-0644/$-see front matter

doi:10.1016/j.annemergmed.2005.04.003

SEE EDITORIAL, P. 19.

INTRODUCTION

Emergency department (ED) presentations for decompensated heart failure account for the majority of the 995,000 annual hospital admissions for this disease process.[1] To facilitate efficient, effective care for these patients, rapid and accurate detection of acute decompensated heart failure must be accomplished. Unfortunately, the dyspneic ED patient often presents a diagnostic dilemma. Misdiagnosis of heart failure can result in significant morbidity and mortality.[2] Treatment interventions for patients with similar conditions that present with dyspnea, such as pneumonia and chronic obstructive

*Members of the ADHERE SAC and Study Group are listed in the Appendix.

Editor's Capsule Summary

What is already known on this topic

Although chest radiography is routine in the evaluation of patients with shortness of breath thought to be due to congestive heart failure, little is known about the diagnostic accuracy of this test for this condition.

What question this study addressed

This secondary analysis of a case registry examined the sensitivity of the emergency department (ED) chest radiograph and the sensitivity of the ED final diagnosis in a cohort of admitted patients who either had a primary hospital discharge diagnosis of acute decompensated congestive heart failure or were treated for this condition during their hospital stay.

What this study adds to our knowledge

Almost 20% of patients deemed to have heart failure during their inpatient stay had a chest radiograph read as negative for signs of congestion in the ED. These patients were more likely to be given diagnoses other than heart failure in the ED than patients whose chest radiographs had signs of congestion.

How this might change clinical practice

Although this study is limited by its data source, a registry, and potential misclassification biases in its criterion standard, it supports the concept that chest radiography has imperfect sensitivity for acute decompensated heart failure.

pulmonary disease, are often administered until a correct diagnosis of acute decompensated heart failure has been made.

A definitive diagnosis of acute decompensated heart failure is often based on right-sided heart catheterization results or indirect measurement of ejection fraction by radionuclide scanning or echocardiography. Lack of immediate availability and cost make these studies prohibitive as ED screening tests. As a result, an ED diagnosis of acute decompensated heart failure is often based on medical history and physical examination findings, along with ancillary tests such as chest radiography and ECG. The unreliability of physical examination findings has been well documented.[3] Although chest radiography is quick and inexpensive, previous research suggests that it may be misleading in ED patients with acute decompensated heart failure, resulting in misdiagnosis and inappropriate treatment.[4,5] We sought to evaluate the sensitivity and negative-result rate of chest radiography in a cohort of ED patients with signs and symptoms of acute decompensated heart failure.

MATERIALS AND METHODS

Study Design and Setting

This was a secondary analysis of registry data for ED patients enrolled in the Acute Decompensated Heart Failure National Registry (ADHERE) between October 2001 and May 2004. ADHERE is an ongoing registry of acute decompensated heart failure patients. The registry has been previously described in detail.[6] At the time of analysis, there were 279 hospitals participating in the registry. The institutional review board at each center approved the registry protocol, and all patient data are kept confidential through encrypted treatment.

Selection of Participants

Patients who were at participating hospitals and were discharged from an inpatient setting with a primary *International Classification of Diseases, Ninth Revision (ICD-9)* code indicating a discharge diagnosis of decompensated heart failure (ie, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.9, 428.20 to 428.23, 428.30 to 428.33, 428.40 to 428.43) or whose primary focus of treatment was heart failure were included. Cases included in the database because "a primary focus of treatment was heart failure" were identified by individual sites by reviewing the medical records of patients with a secondary discharge diagnosis of heart failure to determine whether the subject met inclusion and exclusion criteria.

Inclusion criteria for the registry are (1) age 18 years or older at admission to the hospital; and (2) received or is eligible to receive a principal hospital discharge diagnosis of heart failure or decompensated heart failure is present as determined clinically by the patient care team. Exclusion criterion was heart failure present as a comorbid condition but not a principal focus of diagnosis or treatment during this hospitalization episode.

Inclusion criteria specific for this analysis required the recording of an ED principal diagnosis (defined as any ED *ICD-9* diagnosis) and radiographic findings within 4 hours of ED presentation. All patients with indeterminate chest radiographs were excluded from this analysis. Indeterminate chest radiographs are radiographs that did not have a clear statement in the dictation about the presence or absence of congestion.

Methods of Measurement

The medical record review methods for ADHERE have been described.[6] Briefly, each site designates one person as the registry coordinator. This person is responsible for all data abstraction and receives 2 hours of training before gaining access to online data transfer forms on a secure Web site. Registry coordinators receive ongoing training of at least 2 hours at annual investigator meetings. Cases are identified as described above. A standardized electronic medical record abstraction form is used. There is a codebook that accompanies the electronic case report form, providing operational definitions of important variables. Data are collected at each institution and entered using a Web-based electronic data capture system designed by Phase Forward (Waltham, MA) and licensed by the study contract research organization, PharmaLink FHI (Research Triangle Park, NC). Data recorded include demographics, medical history, nonintravenous and intravenous cardiovascular medications, initial evaluation (at site hospital),

chronic infusion therapy, hospital course, disposition, procedures, and Joint Commission on Accreditation of Healthcare Organizations quality indicators. Record reviewers are not blinded to clinical information about the patient.

Monitoring is performed by aggregate review of several variables: site number, patient number, admission data, admission time, date of birth, disposition date, and disposition time. When errors are encountered, the sites are queried, and casebooks remain unclosed until the discrepancies are resolved.

The main variables examined in this analysis included ED principal diagnosis of acute decompensated heart failure, defined as ED *ICD-9* diagnosis of acute decompensated heart failure, and radiographic findings of heart failure. Radiographic findings of acute decompensated heart failure were defined as presence of pulmonary edema, vascular congestion, or interstitial edema. Radiographic findings of heart failure were based on a staff radiologist's interpretation. The criterion standard for a diagnosis of acute decompensated heart failure was a hospital discharge *ICD-9* code of acute decompensated heart failure or subjects whose primary focus of treatment was heart failure during hospitalization.

Primary Data Analysis

Data are described using means and SDs for age and frequencies and proportions for other variables. The 95% confidence intervals (CIs) for proportions have been computed using the score method with continuity corrections.[7] Sensitivity and negative rate of radiographic findings were calculated under the assumption that every patient with a primary hospital discharge diagnosis of heart failure and positive radiographic findings of heart failure was a true positive. Software used for the analysis was Microsoft Excel (Microsoft Corporation, Redmond, WA).

Sensitivity Analysis

Inclusion of the subgroup of patients identified as having heart failure by "a primary focus of treatment was heart failure" may have introduced selection bias to the results. A sensitivity analysis excluding this patient group was conducted, and the prevalence of radiographic signs of congestion in the cohort of patients identified by a "primary *ICD-9* code indicating a discharge diagnosis of acute decompensated heart failure" is reported in addition to the primary results.

RESULTS

Data for this analysis were abstracted from the ADHERE registry on June 1, 2004, at which time there were 121,658 patients enrolled; 26,962 were excluded because they did not originate in the ED, and 9,320 did not have a yes/no answer for radiographic signs of congestion (the answer was either missing or the result was indeterminate). There were 85,376 patients meeting inclusion criteria for this analysis. Of these, 79,762 patients were identified by a primary *ICD-9* code indicating a discharge diagnosis of acute decompensated heart failure, and 5,614 were enrolled based on heart failure being a primary focus of treatment. Mean patient age was 73.0 years (SD 14.1 years), 54% were female patients, and 71% were white patients. Patients with negative and positive chest radiograph results were similar with regard to the prevalence of chronic hypertension, diabetes, coronary artery disease, and systolic dysfunction. The number of patients with negative and positive chest radiograph results was also similar across age and sex (Table 1).

Of the 85,376 patients, 15,937 patients had no positive findings of heart failure on ED chest radiography (Table 2), yielding a negative rate for ED chest radiography of 18.7% (95% CI 18.4% to 18.9%) and sensitivity of 81.3% (95% CI 81.1% to 81.6%). The proportion of patients with an ED non–acute decompensated heart failure diagnosis was higher in patients who had negative findings on chest radiography (23.3% [3,706/15,937]; 95% CI 22.6% to 23.9%) than in patients with positive findings on chest radiography (13.0% [9,004/69,439]; 95% CI 12.7% to 13.2%). Overall, the proportion of patients with an ED non–acute decompensated heart failure diagnosis was 14.9% (12,710/85,376) (95% CI 14.7% to 15.1%) and sensitivity of an ED diagnosis of acute decompensated heart failure was 85.1% (72,663/85,376) (95% CI 84.9% to 85.4%).

Analysis excluding the 7% of patients who did not have a primary discharge diagnosis of acute decompensated heart failure is presented in Table 3. The proportion of patients with an ED non–acute decompensated heart failure diagnosis was again higher in patients who had negative findings on chest radiography (19.0%) than in patients with positive findings on chest radiography (10.6%). Although this difference was smaller (19.0% versus 10.6%) than that of the original group (23.3% versus 13.0%), the negative rate of ED chest radiography was similar (18.2% versus 18.7%).

LIMITATIONS

Several limitations of registry data apply to this study. This registry is a convenience sample, and there is likely a component of selection bias because only admitted patients are enrolled. The exclusion of heart failure patients discharged directly from the ED and of patients with a secondary or comorbid heart failure diagnosis may have resulted in some spectrum bias in the results; the results from this analysis apply only to the cohort of patients admitted to the hospital, not the entire spectrum of ED patients with heart failure. Both groups of patients are likely to have had fewer signs of congestion on chest radiograph and would increase the number of false-negative chest radiograph results. *ICD-9* codes were used to identify patients with primary decompensated heart failure. *ICD-9* codes do not always reflect the hospital discharge diagnosis or the ED presenting condition (which may have accurately been a non–heart failure diagnosis) and may misrepresent the number of patients with decompensated heart failure.

Although we do not know how each treating physician determined a discharge diagnosis of heart failure, it is likely that chest radiograph findings were considered, introducing incorporation bias.

No uniform or standardized criteria were used to define radiographic findings of congestion, and radiographs were not

Table 1. Comparison of demographic characteristics, medical comorbidities, and echocardiographic findings of patients with a hospital discharge diagnosis of decompensated heart failure.

Characteristic	All Patients, N=85,376	Chest Radiograph Evaluation	
		Positive, N=69,439*	Negative, n=15,937*
Age, mean (SD), y	73.0 (14.1)	73.3 (13.9)	71.6 (14.5)
Sex			
No mention	4 (<0.1)	3 (<0.1)	1 (<0.1)
Male	39,669 (46.5)	31,952 (46.0)	7,717 (48.4)
Female	45,703 (53.5)	37,484 (54.0)	8,219 (51.6)
Race			
No mention	2,926 (3.4)	2,372 (3.4)	554 (3.5)
White	60,220 (70.5)	49,342 (71.1)	10,878 (68.3)
Black	18,419 (21.6)	14,632 (21.1)	3,787 (23.8)
Asian	443 (0.5)	366 (0.5)	77 (0.5)
Hispanic	2,549 (3.0)	2,049 (3.0)	500 (3.1)
Other	819 (1.0)	678 (1.0)	141 (0.9)
Past Medical History			
Coronary artery disease (No., %)	48,760 (57.1)	39,938 (57.5)	8,822 (55.3)
Chronic HTN	63,786 (74.7)	52,119 (75.1)	11,667 (73.2)
Diabetes	37,701 (44.1)	31,214 (45.0)	6,487 (40.7)
History of heart failure	63,938 (75.0)	52,095 (75.0)	11,843 (74)
Cardiac valvular disease	18,099 (21.2)	14,941 (21.5)	3,158 (19.8)
Atrial fibrillation	25,698 (30.1)	21,125 (30.4)	4,573 (28.7)
Ventricular fibrillation	867 (1.1)	706 (1.0)	161 (1.0)
Ventricular tachycardia	6,059 (7.1)	4,853 (7.0)	1,206 (7.6)
Echocardiography Findings			
LVEF%, mean (SD)†	38.3 (17.1)	38.4 (16.9)	38.2 (17.6)
LVEF <40%†	35,580/ 68,850 (51.6)	29,066/ 56,222 (51.7)	6,514/ 12,628 (51.6)

HTN, Hypertension; *LVEF*, left ventricular ejection fraction.
*Positive chest radiograph result indicates record of pulmonary edema, vascular congestion, or interstitial edema as diagnosed by staff radiologist, and negative indicates none of these findings. Data are presented as No. (%) unless otherwise indicated.
†Echocardiogram findings performed during index hospitalization only; 68,850 patients had an echocardiogram during this hospitalization.

evaluated by a core group of radiologists blinded to patient information. These factors may lead to miscategorization of the diagnostic accuracy of signs of congestion on chest radiography.

Patients with decompensated heart failure and a negative chest radiograph result may have been treated and diagnosed appropriately by the emergency physician. However, by the time the admitting physician evaluated the patient, he or she may have already been compensated, resulting in a hospital discharge diagnosis of non–acute decompensated heart failure. The converse could also be true: those with a non–heart failure ED diagnosis could have developed heart failure in the hospital, leading to a primary discharge diagnosis of heart failure, which could have resulted in an increase in the number of discordant ED diagnoses.

Distinguishing between cardiac and noncardiac causes of dyspnea by relying solely on tests available to the emergency physician is difficult. The availability of ancillary tests and information pertaining to response to treatment often affords a more accurate diagnosis than that determined by the emergency physician. Many of the ED discordant non–acute decompensated heart failure diagnoses may have resulted from definitive inhospital testing that revealed evidence of cardiac dysfunction, resulting in a hospital discharge diagnosis of acute decompensated heart failure.

The treating physicians did not follow standardized criteria when determining the cause of each patient's dyspnea, which reflects actual practice in the majority of hospitals. Not following standardized criteria could lead to under- and overdiagnosis of decompensated heart failure because diagnostic criteria would not be consistent from one physician to the next.

DISCUSSION

In this study, approximately 1 of every 5 patients with decompensated heart failure had no signs of congestion on ED chest radiography. Patients who lacked signs of congestion on ED chest radiography were more likely to have an ED diagnosis of non–acute decompensated heart failure than were patients with radiographic signs of congestion. Our findings are consistent with previous studies, which found chest radiography unreliable in ED patients who had signs and symptoms of decompensated heart failure. Twenty percent of cardiomegaly observed on echocardiography is missed on chest radiography,[4] and pulmonary congestion can be minimal or absent in patients with significantly elevated pulmonary artery wedge pressures.[5] A recent evaluation of radiograph findings in dyspneic ED patients found that although cephalization, interstitial edema, and alveolar edema were highly specific (96%, 98%, and 99%,

Table 2. Comparison of patients with a hospital discharge diagnosis of decompensated heart failure to results of evaluation of ED chest radiograph in all ADHERE patients.

		Chest Radiograph Evaluation	
ED Principal Admitting Diagnosis	**All Patients, N=85,376†**	**Positive, n=69,439*,†**	**Negative, n=15,937***
Non–heart failure	12,710 (14.9)	9,004 (13.0)	3,706 (23.3)
Other noncardiac	4,703 (5.5)	3,380 (4.9)	1,323 (8.3)
Chest pain/rule out MI	2,547 (3.0)	1,638 (2.4)	909 (5.7)
COPD/asthma	868 (1.0)	597 (1.0)	271 (1.7)
Acute MI	599 (1.0)	476 (1.0)	123 (1.0)
Unstable angina	374 (<1)	239 (<1)	135 (1.0)
Other cardiac	789 (1.0)	549 (1.0)	240 (1.5)
Ventricular arrhythmia	67 (<1)	46 (<1)	21 (<1)
Atrial fibrillation	966 (1.0)	727 (1.0)	239 (1.5)
Other arrhythmia	123 (<1)	82 (<1)	41 (<1)
Hypertension	434 (1.0)	340 (<1)	94 (1.0)
Respiratory infection	876 (1.0)	651 (1.0)	225 (1.4)
Renal insufficiency or failure	364 (<1)	279 (<1)	85 (1.0)
Heart failure	72,663 (85.1)	60,432 (87.0)	12,231 (76.7)

COPD, Chronic obstructive pulmonary disease; *MI*, myocardial infarction.
*Positive chest radiograph result indicates record of pulmonary edema, vascular congestion, or interstitial edema as diagnosed by staff radiologist, and negative indicates none of these findings. Data are presented as No. (%) unless otherwise indicated.
†Three subjects with ''positive'' chest radiography results were not given an ED principal admitting diagnosis.

Table 3. Comparison of patients with a hospital discharge diagnosis of decompensated heart failure to results of evaluation of ED chest radiograph only in ADHERE patients with a primary discharge diagnosis of acute decompensated heart failure.

		Chest Radiograph Evaluation	
ED Principal Admitting Diagnosis	**All Patients, N=79,762†**	**Positive, n=65,176*,†**	**Negative, n=14,586***
Non–heart failure	9,681 (12)	6,910 (10.6)	2,771 (19.0)
Heart failure	70,081 (88)	60,432 (89.4)	11,815 (81.0)

*Positive chest radiograph result indicates record of pulmonary edema, vascular congestion, or interstitial edema as diagnosed by staff radiologist, and negative indicates none of these findings. Data are presented as No. (%) unless otherwise indicated.
†Three subjects with ''positive'' chest radiography results were not given an ED principal admitting diagnosis.

respectively) for decompensated heart failure, their low sensitivity (41%, 27%, and 6%, respectively) makes them poor screening tools.[8]

Although the study did not subject patients to a true criterion standard for the diagnosis of heart failure, the benefit of inhospital testing improves the clinical likelihood of an accurate hospital discharge diagnosis. Furthermore, the increased number of ED non–acute decompensated heart failure diagnoses in patients with no evidence of congestion on chest radiograph suggests a possible link between lack of congestion on chest radiograph and an increase in the proportion of patients with an ED nonacute decompensated heart failure diagnosis.

The emergency physician ultimately relies on a combination of medical history, physical examination, and diagnostic test results when deciding on a source of a patient's dyspnea. There are several clinical findings commonly used to assist in the diagnosis of heart failure in the ED, including the S3 gallop, jugular venous distention, lower extremity edema, and dyspnea. However, although these findings have reasonable specificity, they have less-than-ideal sensitivity,[3,8,9] and the inconsistency of these findings makes them poor screening tools. The recent introduction of B-type natriuretic peptide helps to overcome some of these limitations, but the test lacks specificity at intermediate concentration levels (ie, 100 to 400 pg/mL), which results in an intermediate ''gray zone'' that presents a diagnostic dilemma for the examining physician.[10] When used together, multiple diagnostic tests can improve the diagnostic ability of the emergency physician.

We chose to examine only the reliability of the presence of congestion on chest radiography in ED patients with acute decompensated heart failure and found a sensitivity of 81%. The presence of cardiomegaly has been shown to have moderate sensitivity (79%) and specificity (80%). Pleural effusion, when present, has been shown to be highly suggestive of acute decompensated heart failure in ED patients (sensitivity 25%; specificity 92%).[8] Furthermore, radiographic findings diagnostic of alternative conditions (eg, infiltrate, pneumothorax) improve emergency physicians' diagnostic ability. It might be suggested, therefore, that despite a nearly 20% negative rate in patients ultimately found to have acute decompensated heart failure, chest radiography may be one of the more sensitive, readily available tests available to the emergency physician. Our findings also suggest that the emergency physician should not ignore this negative rate when basing a diagnosis of acute decompensated heart failure on a chest radiograph.

In conclusion, we found that ED chest radiography lacks signs of congestion in nearly 20% of patients who have a hospital discharge diagnosis of acute decompensated heart failure. Patients who had negative chest radiograph results were more likely to have an ED non–acute decompensated heart failure diagnosis than were patients who had positive chest radiograph results. The percentage of false-negative chest radiographs was consistent across sex and race, which is an important finding. Clinicians should consider the prevalence of chest radiography that lacks signs of congestion when evaluating patients for possible acute decompensated heart failure.

Supervising editor: Terry L. Vanden Hoek, MD

Author contributions: SPC was responsible for study design. SPC was responsible for study implementation. SPC and CJL conducted data analysis. ABS was responsible for institutional review board submission. WTA served as a Department of Cardiology consultant for the program. All authors were involved

in data interpretation and manuscript preparation. SPC takes responsibility for the paper as a whole.

Funding and support: The authors report this study did not receive any outside funding or support but did have database support from ADHERE.

Publication dates: Received for publication August 18, 2004. Revisions received November 16, 2004, January 28, 2005, and March 3, 2005. Accepted for publication April 5, 2005. Available online June 20, 2005.

Address for reprints: Sean P. Collins, MD, University of Cincinnati, Department of Emergency Medicine, 231 Albert Sabin Way, Cincinnati, OH 45267; 513-558-8079, fax 513-558-5791; E-mail sean.collins@uc.edu.

REFERENCES

1. Graff L, Orledge J, Radford MJ, et al. Correlation of the Agency for Health Care Policy and Research congestive heart failure admission guideline with mortality: peer review organization voluntary hospital association initiative to decrease events (PROVIDE) for congestive heart failure. *Ann Emerg Med*. 1999; 34:429-437.
2. Bales AC, Sorrentino MJ. Causes of congestive heart failure: prompt diagnosis may affect prognosis. *Postgrad Med*. 1997;101: 44-49, 54-56.
3. Stevenson LW, Perloff JK. The limited reliability of physical signs for estimating hemodynamics in chronic heart failure. *JAMA*. 1989; 261:884-888.
4. Kono T, Suwa M, Hanada H, et al. Clinical significance of normal cardiac silhouette in dilated cardiomyopathy: evaluation based upon echocardiography and magnetic resonance imaging. *Jpn Circ J*. 1992;56:359-365.
5. Mahdyoon H, Klein R, Eyler W, et al. Radiographic pulmonary congestion in end-stage congestive heart failure. *Am J Cardiol*. 1989;63:625-627.
6. Adams KF, Fonarow GC, Emerman CL, et al. Characteristics and outcomes of patients hospitalized for heart failure in the United States: rationale, design, and preliminary observations from the first 100,000 cases in the Acute Decompensated Heart Failure National Registry (ADHERE). *Am Heart J*. 2005;149:209-216.
7. Newcombe R. Two-sided confidence intervals for the single proportion: comparison of seven methods. *Stat Med*. 1998;17: 857-872.
8. Knudsen CW, Omland T, Clopton P, et al. Diagnostic value of B-type natriuretic peptide and chest radiographic findings in patients with acute dyspnea. *Am J Med*. 2004;116:363-368.
9. Davie AP, Francis CM, Caruana L, et al. Assessing diagnosis in heart failure: which features are any use? *QJM*. 1997;90:335-339.
10. Maisel AS, Krishnaswamy P, Nowak RM, et al. Rapid measurement of B-type natriuretic peptide in the emergency diagnosis of heart failure. *N Engl J Med*. 2002;347:161-167.

Appendix. The ADHERE Registry Scientific Advisory Committee

William T. Abraham, MD, FACP, FACC, The Ohio State University Heart Center, Columbus, OH; Kirkwood F. Adams, Jr, MD, University of North Carolina, Chapel Hill, NC; Robert L. Berkowitz, MD, PhD, Hackensack University Hospital, Hackensack, NJ; Maria Rosa Costanzo, MD, Midwest Heart Specialists, Naperville, IL; Teresa De Marco, MD, University of California, San Francisco, CA; Charles L. Emerman, MD, FACEP, Cleveland Clinic Foundation, Cleveland, OH; Gregg C. Fonarow, MD, Ahmanson–UCLA Cardiomyopathy Center, Los Angeles, CA; Marie Galvao, MSN, ANP-C, Montefiore Medical Center, Bronx, NY; J. Thomas Heywood, MD, FACC, Loma Linda University Medical Center, Loma Linda, CA; Thierry H. LeJemtel, MD, Albert Einstein Hospital, Bronx, NY; Lynne Warner Stevenson, MD, Brigham and Women's Hospital, Boston, MA; and Clyde W. Yancy, MD, FACC, University of Texas, Southwestern Medical Center Medical Center, Dallas, TX.

The ADHERE Registry Study Group

Sharon Tellyer, DVM, ELS, Department of Clinical Registries, Scios Inc., Fremont, CA; and Janet Wynne, MS, Department of Biostatistics, Scios Inc., Fremont, CA.