Congestive heart failure (CHF) is a major public health problem in developed countries. It is a significant burden to patients, healthcare providers, and society.

Several hospital-based reports have documented that a high proportion of patients with CHF have normal left ventricular (LV) systolic function, and 4 different epidemiological investigations further confirmed that nearly half of CHF subjects in the community have normal LV systolic function. This condition is commonly referred to as diastolic heart failure (DHF). Hospital readmission rates for patients with DHF are similar to those for patients with systolic heart failure (SHF), and it is estimated that DHF accounts for 25% of the total cost of CHF, which is estimated at $15 to $40 billion annually. A distinction between DHF and SHF is important because DHF is associated with better long-term survival and because these 2 forms of heart failure require different therapeutic approaches.

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Although the societal burden of DHF is high and its economic impact substantial, it is intriguing that most national and international guidelines either do not consider the condition or underscore that a paucity of information about it precludes any definitive therapeutic recommendations. Numerous clinical trials have documented the benefits of treatment for SHF; however, the optimal treatment for DHF has not yet been defined. The first step toward evaluating any potential treatment for DHF is to develop uniform criteria for its diagnosis. This task, however, is complicated by the pathophysiological heterogeneity of DHF and by the limitations of currently available noninvasive modalities for diagnosing LV diastolic dysfunction.

Diagnosis of Congestive Heart Failure: Role of Imaging Studies and Related Biases

Heart failure is defined as “a pathophysiological state in which an abnormality of cardiac function is responsible for failure of the heart to pump blood at a rate commensurate with metabolic requirements or to do so only from an elevated filling pressure.” Patients who meet this definition of heart failure are a heterogeneous group and have diverse reasons for the occurrence of elevated LV filling pressure and/or a low cardiac output. CHF is a clinical syndrome in which heart failure is accompanied by the symptoms and signs of pulmonary and/or peripheral congestion. Further stratification of CHF subjects into those with LV systolic dysfunction and those with predominantly LV diastolic dysfunction has been suggested because of the important therapeutic and prognostic differences between these 2 subsets of CHF patients.

Recently, the European Society of Cardiology proposed guidelines for the diagnosis of CHF. These guidelines require objective evidence of LV dysfunction for a diagnosis of CHF. This requirement for evidence of LV dysfunction stemmed from evidence of inaccuracies in the clinical diagnosis of CHF, especially in women, the elderly, and the obese. Other investigators have also supported the need for an imaging study to assess LV function as a part of the diagnosis of CHF. We think that although the assessment of LV systolic function is critical in determining the optimal treatment for patients with CHF, the diagnosis of CHF is clinical and should not be made on the basis of LV ejection fraction (EF). Furthermore, for some research studies, the diagnosis of CHF should be made with the physician blinded to LV systolic function to avoid potential diagnostic biases.

Requiring objective evidence of LV dysfunction to diagnose CHF would inevitably lead to an underestimation of the occurrence of DHF in the community. This is because although definitive evidence of LV systolic dysfunction is easily obtained from the LVEF, unequivocal evidence of LV diastolic dysfunction is difficult to obtain by noninvasive methods (see below). Consider an elderly patient presenting with exertional dyspnea, paroxysmal nocturnal dyspnea, and pedal edema. If the LVEF=0.30, a diagnosis of SHF is readily accepted by the clinician. However, if the LVEF≥0.50, the diagnosis of SHF may be doubted. The existence of such clinical biases in diagnosis can result in a systematic and serious underestimation of DHF in the community. In this context, it is important to emphasize that the signs and symptoms of CHF correlate poorly, if at all, with LVEF. Thus, a normal LVEF should not be used to reject a diagnosis of CHF if the clinical presentation is convincing. Legitimate concerns about false-positive diagnoses of CHF...
can be adequately addressed by requiring clinicians to consider carefully and to rule out alternative diagnoses that can masquerade as CHF before making a diagnosis of CHF.24

**Proposed Criteria for DHF According to Degree of Diagnostic Certainty**

Recently, a European Study Group proposed criteria for the diagnosis of DHF.25 The simultaneous presence of the following 3 criteria was considered obligatory for establishing a diagnosis of DHF: (1) evidence of CHF, (2) normal or mildly abnormal LV systolic function, and (3) evidence of abnormal LV relaxation, filling, distensibility, or diastolic stiffness. Although the formulation of these diagnostic criteria represents a significant advance, the immediate clinical usefulness of these criteria is limited because of the third criterion. A comprehensive assessment of LV diastolic function has not been integrated into routine clinical practice in echocardiography laboratories. Furthermore, even if the various indices of LV diastolic function were measured, the interpretation of results is complex and the predictive value of abnormalities in ≥1 of these indices for the presence of LV diastolic dysfunction is currently unknown.

We propose a classification schema for DHF by which patients are categorized according to the degree of diagnostic certainty. This classification approach (Tables 1 to 3) is applicable to patients who do not have CHF attributable to valvular heart disease, cor pulmonale, or a primary volume overload state. A patient who meets the following 3 conditions, in this hierarchical fashion, has definite DHF (Table 1):

1. Definitive evidence of CHF
2. Objective evidence of normal LV systolic function in proximity to the CHF event
3. Objective evidence of LV diastolic dysfunction

The first step in the diagnosis of DHF is to establish a diagnosis of CHF. Definitive evidence of CHF in a hospital-based setting typically consists of the presence of signs and symptoms compatible with a diagnosis of CHF; laboratory tests (such as a chest X-ray) that support this diagnosis, and a typical clinical response to treatment with diuretics; documentation of elevated LV filling pressures or a low cardiac index may or may not also be present.16 The second step in establishing a diagnosis of DHF is to document normal LV systolic function in proximity to the episode of CHF. An LVEF≥0.50, obtained either by echocardiography or with radionuclide angiography, is evidence of normal LV systolic function.5,26 Definitive objective evidence of ventricular diastolic dysfunction requires cardiac catheterization.27,28 This would typically involve demonstrating an increased LV end-diastolic filling pressure in the presence of a normal or reduced LV end-diastolic volume.

Often, when the first 2 criteria are fulfilled, it is not possible to obtain objective evidence of LV diastolic dysfunction. It is not feasible to subject all CHF patients to cardiac catheterization. Furthermore, even when cardiac catheterization is performed, typically, patients are clinically stabilized and well diuresed before the procedure; these circumstances influence the sensitivity of the test procedure itself. In addition, currently available noninvasive assessments of LV diastolic function are imprecise. Under these circumstances, we think that it is reasonable to accept that the cause of CHF in patients with a normal LVEF is probably LV diastolic dysfunction once mitral valve disease, cor pulmonale, primary volume overload conditions, and noncardiac causes of symptoms are excluded.24,29 These patients can be categorized as having probable DHF (Table 2); it is highly probable that LV diastolic dysfunction is the basis of their clinical symptoms.

A third category exists, that of patients who have a history of CHF, currently have normal LV systolic function (ie, LV function was not obtained in proximity to the CHF event), and who have not undergone an evaluation of LV diastolic function. We suggest that such patients be considered to have possible DHF (Table 3). Less diagnostic certainty exists in such patients.

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**TABLE 1. Criteria for Definite DHF**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Objective Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitive evidence of CHF AND Objective evidence of normal LV systolic function in proximity to the CHF event</td>
<td>Includes clinical symptoms and signs, supporting laboratory tests (such as chest X-ray), and a typical clinical response to treatment with diuretics, with or without documentation of elevated LV filling pressure (at rest, on exercise, or in response to a volume load) or a low cardiac index</td>
</tr>
<tr>
<td>Objective evidence of LV diastolic dysfunction</td>
<td>Abnormal LV relaxation/filling/distensibility indices on cardiac catheterization</td>
</tr>
</tbody>
</table>

**TABLE 2. Criteria for Probable DHF**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Objective Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitive evidence of CHF AND Objective evidence of normal LV systolic function in proximity to the CHF event</td>
<td>Includes clinical symptoms and signs, supporting laboratory tests (such as chest X-ray), and a typical clinical response to treatment with diuretics, with or without documentation of elevated LV filling pressure (at rest, on exercise, or in response to a volume load) or a low cardiac index</td>
</tr>
<tr>
<td>Objective evidence of LV diastolic dysfunction is lacking</td>
<td>No conclusive information on LV diastolic function</td>
</tr>
</tbody>
</table>

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compared with subjects in the second category because these patients may have had transient LV systolic dysfunction during the episode of acute CHF.

A diagnosis of possible DHF can be upgraded to probable DHF if the clinical setting is typical for the presence of LV diastolic dysfunction (Table 4). The presence of markedly elevated blood pressure during the episode of CHF favors a diagnosis of DHF because a failing LV with systolic dysfunction is more likely to result in a normal or low blood pressure. Echocardiographic evidence of moderate concentric hypertrophy without concomitant wall motion abnormalities increases the likelihood of DHF. A transient fall in LVEF during the episode of CHF with a subsequent rebound is unlikely in the presence of LV hypertrophy and in the absence of significant ischemia. The presence of a tachyarrhythmia with shortened diastolic filling or atrial fibrillation, with a resultant loss of the atrial “kick” during the episode of CHF, increases the likelihood of DHF. In these settings, subclinical LV diastolic dysfunction was likely unmasked by the rapid heart rate. A left ventricle with normal systolic and diastolic function is unlikely to fail due to an acute increase in heart rate. Likewise, the onset of CHF after the administration of a small amount of intravenous fluid in a patient with a normal LVEF suggests a diagnosis of probable DHF (with underlying LV diastolic dysfunction) because individuals with normal LV systolic and diastolic function can tolerate a considerable volume load without developing CHF. If symptoms in a patient with possible DHF improve with treatment directed at the underlying cause of diastolic dysfunction (such as lowering blood pressure, controlling a rapid heart rate, or restoring atrioventricular synchrony), the diagnosis may be upgraded to probable DHF to indicate an increase in diagnostic certainty.

Epidemiological studies use scoring systems for establishing a diagnosis of CHF. These approaches combine clinical symptoms and signs with laboratory tests to yield a “heart failure score,” which is then used to establish the presence or absence of CHF. If LV systolic function is normal, the heart failure score suggests the presence of CHF and, if a noncardiac cause of symptoms is not present, a diagnosis of possible DHF can be made. It must be underscored that a greater degree of diagnostic certainty may not be achievable in epidemiological settings in which subjects are evaluated at varying times after the onset of CHF.

A diagnosis of DHF is doubtful if heart failure symptoms can be explained by another diagnosis or if objective evidence of normal LV systolic function is lacking. In the first instance, it is likely that the diagnosis of CHF is incorrect. In the second case, the possibility exists of falsely diagnosing LV diastolic dysfunction when LV systolic dysfunction is present. Findings associated with an increased probability of SHF include an abnormal apical impulse (especially sustained duration) and electrocardiographic evidence of an old anterior Q-wave myocardial infarction or a left bundle branch block pattern.

### Causes of DHF

Once a diagnosis of DHF is established, it is important to determine the etiologic mechanism (LV hypertrophy versus ischemia versus other causes) so that treatment can be targeted at the underlying cause. The categorization of DHF patients into etiologically homogeneous groups will also facilitate future clinical trials. We previously discussed in detail such a diagnostic approach to the pathophysiology of DHF.

### Validity of Proposed Criteria and Limitations

The confidence with which a clinician accepts a diagnosis of DHF varies, depending on the quantity and quality of the supportive clinical and laboratory evidence. We propose the following 3 sequential steps for the diagnosis of DHF: (1) establish a diagnosis of CHF, (2) document normal LV systolic function, and (3) document LV diastolic dysfunction, if feasible, and determine the likely cause of DHF. We have proposed a classification system that accepts the practical reality of varying degrees of diagnostic certainty. The proposed classification approach is intended to standardize reporting, to facilitate epidemiological investigations, and to permit valid comparisons of treatment outcomes in future clinical trials.

The validity of the content of the proposed classification merits comment. The construction of a sensible, criterion-based classification system relies on judgment regarding the choice of the constituent criteria for CHF and for DHF. We selected 3 criteria that, in our judgment, make pathophysiological sense, and we proposed a simple hierarchical system of 3 categories indicating different degrees of diagnostic certainty. Similar diagnostic categories have
been used for classifying other disorders for which a variable degree of clinical certainty exists and for which no gold standard for diagnosis exists.\textsuperscript{34,35} The proposed categorization system requires prospective validation; its accuracy (misclassification rate) is presently unknown.

**Future Directions**

The proposed criteria are intended as a framework for the development of a consensual standard for DHF that is applicable in routine clinical practice, epidemiological studies, and clinical trials. A consensual standard is essential for consistency in the diagnosis of DHF in the community-based setting. Standard criteria will permit the collection of epidemiological data for assessing the prevalence, natural history, and prognosis of DHF; they are also essential for community-based surveillance of the condition.\textsuperscript{36} In addition, uniform and consistency in the diagnosis of DHF in the community-based settings. Standard criteria will permit the collection of epidemiological studies, and clinical trials. A consensual standard is essential for applicability in routine clinical practice, epidemiological studies.

References


**Key Words:** heart failure, diastole, echocardiography, imaging, diagnosis
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