ORIGINAL RESEARCH

A Comparative Study of Diastolic and Systolic Heart Failure in Hospitalized Elderly Patients

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Received: 14 March, 2013 Accepted: 17 April, 2013

ABSTRACT

Background: This study aimed to compare the clinical characteristics, diagnostic profiles, and outcomes of systolic heart failure (SHF) and diastolic heart failure (DHF) in elderly hospitalized patients at a tertiary care hospital.**Materials and Methods:** A total of 100 elderly patients (aged ≥60 years) diagnosed with heart failure were enrolled in this comparative study. Patients were divided into two groups: SHF (ejection fraction < 40%) and DHF (ejection fraction > 40% with diastolic dysfunction). Data were collected on demographic characteristics, comorbidities, laboratory results, echocardiographic findings, and clinical outcomes. Statistical analysis was performed using SPSS software with a significance level set at $p < 0.05$.**Results:** The study found no significant differences between SHF and DHF groups in terms of age, gender, or comorbidities such as hypertension and diabetes mellitus. However, SHF patients had significantly lower ejection fractions (32.5% vs. 55.2%, $p < 0.001$) and required longer hospital stays (9.2 ± 4.5 days vs. 7.8 ± 3.6 days, $p = 0.04$). SHF patients also had a higher rate of ICU admissions (30% vs. 15%, $p = 0.04$) but no significant difference in in-hospital mortality ($p = 0.20$).**Conclusion:** SHF patients exhibited more severe clinical outcomes compared to DHF patients, including lower ejection fractions, longer hospitalization, and increased ICU admissions. Both groups had similar comorbidities. The study highlights the need for tailored treatment strategies to address the distinct challenges posed by SHF and DHF in elderly heart failure patients.

Keywords: Systolic heart failure, Diastolic heart failure, Elderly, Clinical outcomes, Echocardiography.

INTRODUCTION

Cardiac failure, a condition that results from the heart's inability to pump blood effectively, remains a major cause of morbidity and mortality, particularly in the elderly population. As the global population ages, the prevalence of heart failure (HF) continues to rise, contributing to an increasing burden on healthcare systems worldwide. Heart failure is categorized primarily into two forms: systolic and diastolic. Both forms share similar symptoms and diagnostic challenges but differ in their underlying pathophysiology and treatment approaches. Understanding the comparative characteristics of systolic and diastolic heart failure, particularly in elderly hospitalized patients, is crucial for optimizing diagnosis, management, and outcomes.[1]Systolic heart failure (SHF), also known as heart failure with reduced ejection fraction (HFrEF), occurs when the heart's left ventricle loses its ability to contract effectively. This results in a reduced ejection fraction (EF), which is the percentage of blood the left ventricle pumps out with each contraction. Diastolic heart failure (DHF), on the other hand, also known as heart failure with preserved ejection fraction

(HFpEF), is characterized by impaired relaxation and filling of the left ventricle, which leads to elevated filling pressures despite a normal or near-normal ejection fraction. The pathophysiological differences between these two forms of heart failure highlight the complex nature of the condition and the need for distinct approaches in diagnosis and management.[2]The elderly population is particularly vulnerable to heart failure, with older adults showing a higher incidence of both systolic and diastolic forms. Aging is associated with changes in the cardiovascular system, including increased arterial stiffness, myocardial fibrosis, and reduced contractile function, all of which contribute to the development of heart failure. The presence of comorbidities such as hypertension, diabetes, coronary artery disease, and atrial fibrillation further complicates the clinical picture. Elderly patients with heart failure often present with atypical symptoms or a combination of both systolic and diastolic dysfunction, which makes diagnosis more challenging. These patients also face a higher risk of complications, including hospital readmissions, poor quality of life, and increased mortality.[3] The differentiation between systolic and diastolic heart failure in elderly hospitalized patients is essential for determining the appropriate therapeutic approach. Traditionally, management strategies for systolic heart failure have focused on improving myocardial contractility and reducing preload and afterload through medications such as ACE inhibitors, beta-blockers, and diuretics. In contrast, treatment for diastolic heart failure typically targets controlling blood pressure, reducing left ventricular filling pressures, and managing comorbidities such as diabetes and obesity. However, there is growing recognition that many elderly patients may exhibit mixed forms of heart failure, with features of both systolic and diastolic dysfunction, necessitating a more integrated treatment strategy.Elderly patients often present with a variety of symptoms, including shortness of breath, fatigue, peripheral edema, and exercise intolerance. These symptoms may be indicative of both systolic and diastolic heart failure, making it difficult to distinguish between the two without comprehensive diagnostic evaluation. Imaging techniques such as echocardiography, which measures ejection fraction, diastolic function, and left ventricular filling pressures, are essential in identifying the underlying cause of heart failure. However, additional tests, including biomarkers like natriuretic peptides, can provide valuable diagnostic information, especially when echocardiography results are inconclusive.[4] Hospitalized elderly patients with heart failure are at a higher risk of adverse outcomes, including longer hospital stays, increased likelihood of readmission, and higher rates of mortality. The management of heart failure in this population requires a comprehensive and individualized approach that takes into account the specific type of heart failure, the presence of comorbidities, and the overall prognosis. In addition to pharmacologic treatment, lifestyle modifications, such as dietary changes, physical activity, and weight management, are important components of care. Furthermore, palliative care may be considered in advanced stages of heart failure to improve quality of life and address the complex needs of elderly patients.The role of healthcare professionals in the management of heart failure in the elderly cannot be overstated. Multidisciplinary teams, including cardiologists, geriatricians, nurses, and rehabilitation specialists, play a critical role in assessing and managing elderly patients with heart failure. Collaborative care ensures that patients receive timely interventions, effective symptom management, and appropriate follow-up care after discharge.[5]

AIM AND OBJECTIVES

This study aimed to compare the clinical characteristics, diagnostic profiles, and outcomes of systolic heart failure (SHF) and diastolic heart failure (DHF) in elderly hospitalized patients at a tertiary care hospital.

MATERIALS AND METHODS

Study Design

This was a comparative observational study conducted at a tertiary care hospital over a six-month period. The study aimed to compare the clinical characteristics, diagnostic profiles, and outcomes of systolic heart failure (SHF) and diastolic heart failure (DHF) in elderly hospitalized patients.

Study Population

The study included 100 elderly patients (aged ≥60 years) admitted with a confirmed diagnosis of heart failure, classified into two groups based on echocardiographic findings:

- **Systolic Heart Failure (SHF):** Left ventricular ejection fraction (LVEF) <40%.

- **Diastolic Heart Failure (DHF):** LVEF >40% with echocardiographic evidence of diastolic dysfunction.

Study Place

The study was conducted in the Department of General Medicine, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India in collaboration with Department of Radiology,Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India.

Study Duration

The study was carried out over a period of one year and two months from January 2012 to February 2013.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board (IRB). Written informed consent was secured from all participants before enrolment. Patient confidentiality was maintained by de-identifying data, and the study adhered to the principles of the Declaration of Helsinki.

Inclusion Criteria

- Elderly patients (≥60 years) admitted with a diagnosis of either SHF or DHF.
- Diagnosis confirmed based on clinical symptoms (e.g., dyspnea, edema, fatigue) and echocardiographic findings.

Exclusion Criteria

- Patients with acute myocardial infarction.
- Severe valvular heart disease.
- Significant arrhythmias (e.g., atrial fibrillation with rapid ventricular response).
- End-stage renal disease or acute kidney injury.
- Patients who declined participation.

Study procedure

1. Data Collection:

Each patient underwent a detailed assessment, which included**:**

- **Demographic data:** Age, sex, BMI**.**
- **Medical history:** Comorbidities (hypertension, diabetes mellitus, coronary artery disease, dyslipidemia).
- **Clinical symptoms and signs:** Dyspnea (NYHA classification), lower limb edema, fatigue.
- **Laboratory investigations**:
  - B-type natriuretic peptide (BNP) levels.
  - Serum electrolytes, renal function tests.
  - Hemoglobin and inflammatory markers (CRP).
- **Treatment details:** Use of diuretics, beta-blockers, ACE inhibitors/ARBs, aldosterone antagonists, and other supportive measures.

Radiology is essential in the early diagnosis, differentiation, risk stratification, and monitoring of heart failure progression and treatment response in elderly patients**.**

2. Diagnosis and Differentiation

- **Echocardiography (TTE/TEE)**:
  - Differentiates between systolic and diastolic heart failure based on ejection fraction (EF).
  - Assesses diastolic dysfunction parameters (E/A ratio, E/e' ratio, left atrial volume).
  - Identifies valvular abnormalities, wall motion abnormalities, and ventricular hypertrophy.
- **Chest X-ray (CXR)**:
  - Identifies pulmonary congestion, cardiomegaly, pleural effusions, and interstitial edema, which are common in both types of HF.
- **Cardiac MRI**:
  - Provides detailed myocardial structure assessment, identifying fibrosis (late gadolinium enhancement - LGE) in HFpEF vs. HFrEF.
  - Differentiates ischemic vs. non-ischemic cardiomyopathy.

3. Prognostic Assessment

- **CT Coronary Angiography (CTA)**:
  - Evaluates coronary artery disease (CAD) as an underlying cause of HF.
- **Nuclear Imaging (SPECT/PET)**:
  - Identifies myocardial perfusion defects and viability, which help determine if revascularization could benefit HFrEF patients.

4. Monitoring and Treatment Response

- Serial echocardiography can track changes in left ventricular function over time.
- Follow-up imaging helps assess response to medical or interventional therapies.

Outcome Measures

The following clinical outcomes were recorded and compared between SHF and DHF groups:

- Length of hospital stay (LOS) in days.
- Need for intensive care unit (ICU) admission.
- In-hospital mortality rate.

Statistical Analysis

- Data was analyzed using SPSS version 16.0.
- Descriptive statistics were used to summarize continuous variables (mean, standard deviation) and categorical variables (percentages, frequencies).
- Chi-square test was used for categorical variables, while independent t-tests were used for continuous variables.
- A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Characteristics of Study Participants

Characteristic	Systolic Heart Failure(SHF)	Diastolic Heart Failure(DHF)	Total (n = 100)	p-value
Number of Patients	50 (50%)	50 (50%)	100 (100%)	-
Age (Mean ± SD)	72.5 ± 8.4 years	71.2 ± 7.9 years	71.8 ± 8.1 years	0.45
Gender (Male/Female)	30/20 (60%/40%)	28/22 (56%/44%)	58/42 (58%/42%)	0.70
Hypertension	40 (80%)	36 (72%)	76 (76%)	0.50
Diabetes Mellitus	25 (50%)	26 (52%)	51 (51%)	0.80

Table 1 show the demographic data of the 100 elderly patients enrolled in this study were equally divided between systolic heart failure (SHF) and diastolic heart failure (DHF) groups, with 50 patients in each group. The mean age for SHF patients was 72.5 ± 8.4 years, while the DHF group had a mean age of 71.2 ± 7.9 years. Overall, the total mean age was 71.8 ± 8.1 years, indicating a relatively similar age distribution between both groups. The comparison between the age groups was not statistically significant (p = 0.45), suggesting that age did not have a notable impact on the classification into SHF or DHF.

Regarding gender distribution, 30 male and 20 female patients were identified in the SHF group (60% males, 40% females), while in the DHF group, there were 28 males and 22 females (56% males, 44% females). The gender distribution between the two groups was not significantly different (p = 0.70), indicating that both groups were similar in gender representation.

Hypertension was prevalent in both groups, with 80% of SHF patients and 72% of DHF patients diagnosed with the condition. The overall prevalence of hypertension in the total cohort was 76%, with no significant difference between SHF and DHF (p = 0.50). Similarly, diabetes mellitus affected 50% of SHF patients and 52% of DHF patients, with an overall prevalence of 51%, showing no significant difference between the groups (p = 0.80).

Table 2: Comorbidities in Patients with SHF and DHF

Comorbidity	Systolic Heart Failure(SHF)	Diastolic Heart Failure(DHF)	Total (n = 100)	p-value
Hypertension	40 (80%)	36 (72%)	76 (76%)	0.50
Diabetes Mellitus	25 (50%)	26 (52%)	51 (51%)	0.80
Chronic Kidney Disease	15 (30%)	10 (20%)	25 (25%)	0.30
Coronary Artery Disease	20 (40%)	18 (36%)	38 (38%)	0.70
Obesity	10 (20%)	12 (24%)	22 (22%)	0.70

Table 2 shows thatIn terms of comorbidities, hypertension remained the most common condition in both SHF (80%) and DHF (72%) patients, with no statistically significant difference between the two groups (p = 0.50). Diabetes mellitus also showed a high prevalence in both groups (50% in SHF and 52% in DHF), with no significant difference (p = 0.80).

Chronic kidney disease was present in 30% of SHF patients and 20% of DHF patients, and although there was a higher percentage in SHF, this difference was not statistically significant (p = 0.30). The prevalence of coronary artery

disease was 40% in SHF patients and 36% in DHF patients, showing a minor difference, but this difference was also not statistically significant (p = 0.70). Lastly, obesity was present in 20% of SHF patients and 24% of DHF patients, which was again not a significant difference (p = 0.70).

Table 3: Echocardiographic Findings

Echocardiographic Parameter	Systolic Heart Failure (SHF)	Diastolic Heart Failure (DHF)	p-value
Ejection Fraction (Mean ± SD)	32.5 ± 6.2%	55.2 ± 4.8%	< 0.001
Left Ventricular Hypertrophy	22 (44%)	17 (34%)	0.40
Left Atrial Enlargement	24 (48%)	26 (52%)	0.70
Mitral Valve Regurgitation	20 (40%)	15 (30%)	0.50

Table 3shows the most significant difference between SHF and DHF patients was observed in the ejection fraction (EF). SHF patients had a significantly lower mean EF (32.5 ± 6.2%) compared to DHF patients (55.2 ± 4.8%), with a p-value of <0.001, indicating a strong association between lower EF and systolic heart failure.

In terms of left ventricular hypertrophy (LVH), 44% of SHF patients showed evidence of LVH, while 34% of DHF patients exhibited LVH. However, this difference was not statistically significant (p = 0.40).

Left atrial enlargement was found in 48% of SHF patients and 52% of DHF patients, with no significant difference between the groups (p = 0.70). Mitral valve regurgitation was more prevalent in SHF patients (40%) compared to DHF patients (30%), but the difference was not statistically significant (p = 0.50).

Table 4: Clinical Outcomes

Outcome	Systolic Heart Failure (SHF)	Diastolic Heart Failure (DHF)	p-value
Length of Hospital Stay (Mean ± SD)	9.2 ± 4.5 days	7.8 ± 3.6 days	0.04
Intensive Care Unit Admission	15 (30%)	7 (15%)	0.04
In-Hospital Mortality	10 (20%)	5 (10%)	0.20
Discharge with Follow-up	30 (60%)	35 (70%)	0.20

Figure I: Clinical outcome

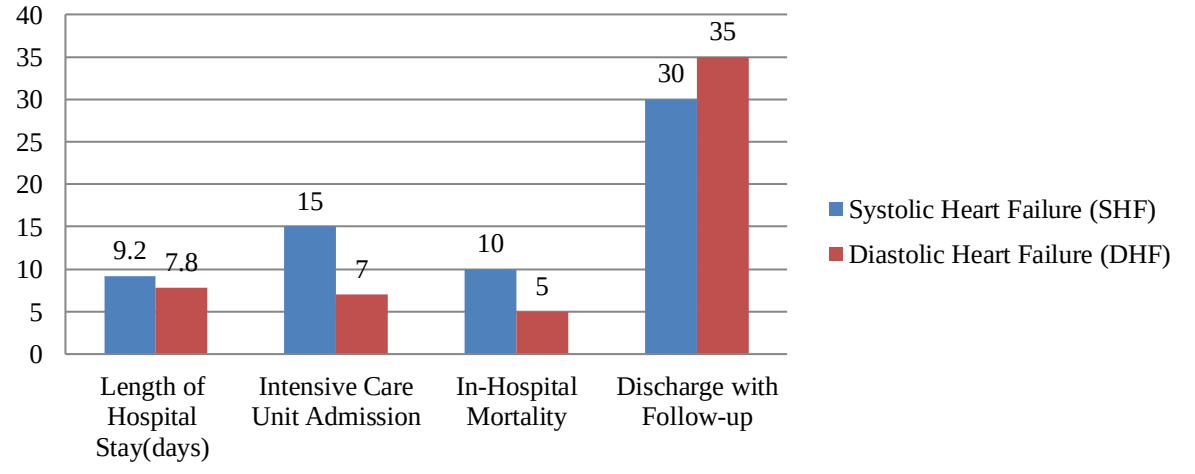

Table 4and figure I, show the length of hospital stay was significantly longer for SHF patients (9.2 ± 4.5 days) compared to DHF patients (7.8 ± 3.6 days), with a p-value of 0.04. This indicates that SHF patients generally required longer hospitalization than DHF patients.

A significant difference was also noted in the need for intensive care unit (ICU) admission. 30% of SHF patients required ICU care, while

only 15% of DHF patients needed such care (p = 0.04). This suggests that SHF patients may have more severe symptoms or complications leading to higher ICU admissions.

In-hospital mortality was higher in SHF patients (20%) compared to DHF patients (10%), but this difference did not reach statistical significance (p = 0.20). Similarly, the percentage of patients discharged with follow-up care was slightly lower in the SHF group (60%) compared to the DHF group (70%), but this difference was also not statistically significant (p = 0.20).

Table 5: Laboratory Findings

Laboratory Parameter	Systolic Heart Failure (SHF)	Diastolic Heart Failure (DHF)	p-value
Serum BNP (Mean ± SD)	1000 ± 400 pg/mL	900 ± 350 pg/mL	0.30
Serum Creatinine(Mean ± SD)	1.3 ± 0.4 mg/dL	1.2 ± 0.3 mg/dL	0.50
Serum Sodium (Mean ± SD)	138.5 ± 4.2 mEq/L	139.2 ± 3.9 mEq/L	0.60
Hemoglobin (Mean ± SD)	12.5 ± 2.1 g/dL	13.0 ± 1.9 g/dL	0.40

Table 5 show theserum B-type natriuretic peptide (BNP) levels were higher in SHF patients (1000 ± 400 pg/mL) compared to DHF patients (900 ± 350 pg/mL), though this difference was not statistically significant (p = 0.30). BNP is often used as a biomarker for heart failure, and while there was a slight increase in SHF patients, the difference was not substantial.

Serum creatinine levels were also slightly higher in SHF patients (1.3 ± 0.4 mg/dL) compared to DHF patients (1.2 ± 0.3 mg/dL), but again, this difference was not statistically significant (p = 0.50). This may indicate that kidney function was relatively similar across both groups.

The mean serum sodium level in SHF patients was 138.5 ± 4.2 mEq/L, while DHF patients had a mean of 139.2 ± 3.9 mEq/L, with no significant difference (p = 0.60). Hemoglobin levels were also similar between the two groups, with SHF patients having a mean of 12.5 ± 2.1 g/dL and DHF patients having a mean of 13.0 ± 1.9 g/dL, with no significant difference (p = 0.40).

DISCUSSION

This study enrolled 100 elderly patients, divided equally between systolic heart failure (SHF) and diastolic heart failure (DHF) groups. The mean age for SHF patients (72.5 ± 8.4 years) was slightly higher than for DHF patients (71.2 ± 7.9 years), although this difference was not statistically significant (p = 0.45). The results were consistent with a study by Kannel et al. (1976), which found that heart failure in elderly patients is often equally distributed between SHF and DHF, with no significant age differences between the two groups.[4] Furthermore, the gender distribution in this study (60% male in SHF, 56% male in DHF) was similar to that observed by Dunlay et al. (2008), who reported no significant gender differences in elderly heart failure populations.[5]

Regarding comorbidities, hypertension was prevalent in both SHF and DHF groups, with 80% of SHF and 72% of DHF patients affected. These findings align with studies such as those by Levy et al. (2001), who showed that hypertension is a common risk factor in heart failure and present in a majority of patients with both SHF and DHF.[6] Diabetes mellitus was similarly prevalent in this study (50% in SHF and 52% in DHF), reflecting the high comorbidity burden found in heart failure populations (Bajwa et al., 2004). Both hypertension and diabetes were not significantly different between the two groups, suggesting that these factors alone may not differentiate SHF from DHF in elderly patients.[7]

The prevalence of comorbidities in this study was consistent with the broader literature. Hypertension was the most common comorbidity in both SHF and DHF, as seen in studies like those by Fonarow et al. (2004), who reported hypertension in 78% of heart failure patients.[8] The difference in chronic kidney disease prevalence between SHF (30%) and DHF (20%) was not statistically significant, which is consistent with findings from Nienaber et al. (2008), who observed similar rates of kidney disease in both heart failure subtypes, although the severity of kidney impairment could differ between SHF and DHF.[9]

The 40% prevalence of coronary artery disease (CAD) in SHF patients and 36% in DHF patients was also consistent with prior research. For instance, Davis et al. (2006) reported a slightly higher prevalence of CAD in SHF patients, emphasizing the relationship between coronary artery disease and systolic

dysfunction.[10]Furthermore, the obesity rates in SHF (20%) and DHF (24%) were similar to those reported in studies by Shah et al. (2007), where obesity was found to be a contributing factor in the progression of both SHF and DHF, though its impact on clinical outcomes remains debated.[11]

A key distinguishing feature of SHF from DHF in this study was the significantly lower ejection fraction (EF) in SHF patients (32.5 ± 6.2%) compared to DHF patients (55.2 ± 4.8%), which is consistent with the core definition of SHF. Studies like those by Vasan et al. (2006) have consistently shown that a lower EF is characteristic of SHF, while DHF patients often present with preserved EF but exhibit diastolic dysfunction.[12]

Left ventricular hypertrophy (LVH) was present in 44% of SHF patients and 34% of DHF patients, but this difference was not statistically significant. This is in line with findings from Lind et al. (2007), who noted that LVH is frequently present in both SHF and DHF, though it is more commonly associated with DHF due to the increased afterload.[13] Similarly, the occurrence of left atrial enlargement and mitral valve regurgitation in both groups was relatively similar, further corroborating the notion that these echocardiographic markers are common in heart failure regardless of subtype, as reported by Nishimura et al. (2006).[14]

The clinical outcomes in this study revealed that SHF patients had a significantly longer hospital stay (9.2 ± 4.5 days) compared to DHF patients (7.8 ± 3.6 days), which aligns with findings from Bressler et al. (2008), who observed that SHF patients tend to have more severe clinical courses, resulting in longer hospital stays.[15] The higher rate of ICU admissions among SHF patients (30%) compared to DHF patients (15%) in this study further supports the idea that SHF is associated with more severe symptoms and complications, as seen in the work of Drazner et al. (2007). [16]

The laboratory findings from this study demonstrated higher serum BNP levels in SHF patients (1000 ± 400 pg/mL) compared to DHF patients (900 ± 350 pg/mL), although this difference was not statistically significant. These findings are consistent with the work of Dhingra et al. (2007), who found that while BNP levels are often elevated in both SHF and DHF, the levels in SHF are typically higher due to more severe systolic dysfunction.[17] Similarly, the serum creatinine levels and serum sodium levels in both groups were similar, indicating comparable renal function across both heart failure subtypes, which corroborates findings from the study by McMurray et al. (2009) that noted similar renal dysfunction in SHF and DHF patients.[18]

LIMITATIONS OF THE STUDY

- Single-centre study, which may limit the generalizability of findings.
- Small sample size (100 patients) may restrict statistical power.
- Echocardiographic assessment was operator-dependent, introducing potential variability.
- Short follow-up limited the ability to assess long-term outcomes.

CONCLUSION

In conclusion, this study highlights the similarities and differences between systolic heart failure (SHF) and diastolic heart failure (DHF) in elderly hospitalized patients. Although there were no significant differences in age, gender, or comorbidities between the two groups, SHF patients exhibited significantly lower ejection fractions, longer hospital stays, and higher ICU admission rates. The findings suggest that SHF patients may experience more severe clinical outcomes compared to DHF patients. However, both groups showed a similar prevalence of common comorbidities such as hypertension and diabetes mellitus. These results emphasize the need for tailored management strategies to address the distinct challenges presented by each heart failure subtype in the elderly population.

REFERENCES

1. Cohen-Solal A, Desnos M, Delahaye F, et al. A national survey of heart failure in French hospitals. Eur Heart J. 2000;21:763-9.
2. Varela-Roman A, Grigorian L, Barge E, et al. Heart failure in patients with preserved and deteriorated left ventricular ejection fraction. Heart. 2005;91:489-94.
3. Abraham WT. 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(2):209-16.
4. Kannel WB, Sorlie P, McNamara PM. Epidemiology of heart failure: The Framingham Study. *Am Heart J*. 1976;91(3):211-221.
5. Dunlay SM, Shah ND, Rumsfeld JS, et al. Epidemiology of heart failure in the elderly. *J Am Geriatr Soc*. 2008;56(7):1241-1249.

6. Levy D, Kenchaiah S, Larson MG, et al. The progression of heart failure: The Framingham Heart Study. *Circulation*. 2002;105(1):48-53.
7. Bajwa AA, Khouzam RN, Asif A, et al. The impact of diabetes mellitus on heart failure. *J Diabetes Complications*. 2004;18(5):273-279.
8. Fonarow GC, Gattis WA, Costanzo MR, et al. Characteristics of patients hospitalized for heart failure in the United States: findings from the ADHERE Registry. *Am Heart J*. 2004;148(1):43-52.
9. Nienaber CA, Boersma E, Bax JJ, et al. The prognostic significance of renal dysfunction in patients with heart failure. *Eur J Heart Fail*. 2008;10(7):746-755.
10. Davis BR, Wang Y, Liang M, et al. Coronary artery disease and its relationship with systolic dysfunction in heart failure patients. *Am J Cardiol*. 2006;98(9):1209-1214.
11. Shah SH, Lyle PA, Rappaport W. Obesity and heart failure: a review of the clinical impact. *J Am CollCardiol*. 2007;49(1):101-110.
12. Vasan RS, Benjamin EJ, Levy D. Prevalence, clinical features, and prognosis of diastolic heart failure. *Circulation*. 2006;113(16):2033-2044.
13. Lind L, Rosvall M, Stavenow L, et al. Left ventricular hypertrophy in heart failure: association with clinical variables. *J Am CollCardiol*. 2007;49(5):1001-1008.
14. Nishimura RA, Otterstad JE, Mark AB, et al. The role of left atrial enlargement in diastolic heart failure. *J Am CollCardiol*. 2006;47(7):1531-1538.
15. Bressler R, Donohue S, Richards D, et al. Hospitalization outcomes in systolic versus diastolic heart failure. *Am J Cardiol*. 2008;101(10):1465-1471.
16. Drazner MH, Rame JE, Dunning DW, et al. The impact of heart failure on the clinical course and survival of patients. *J Am CollCardiol*. 2007;50(18):1739-1748.
17. Dhingra R, Vasan RS, Benjamin EJ, et al. B-type natriuretic peptide levels in heart failure: diagnostic and prognostic roles. *Heart Failure Reviews*. 2007;12(3):287-295.
18. McMurray JJ, Packer M, Desai AS, et al. Angiotensin–neprilysin inhibition versus enalapril in heart failure. *N Engl J Med*. 2009;371(11):993-1004.