Several hospital based reports have documented that high proportion of patients with congestive heart failure (CHF) have normal left ventricular ejection fraction. Four different epidemiological investigation further confirmed that nearly half of CHF subjects in the community have normal LV systolic function. Hospital admission 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 dollars annually.

A distinction between DHF and SHF is important because DHF is associated with greater long term survival and because these two forms of heart failure require different therapeutic approaches.

Definition

As stated above the diastolic heart failure (DHF) refers to the clinical syndrome of heart failure with normal ejection fraction of 50% or more. In simple terms, if a patient has symptoms and signs of heart failure and on echocardiogram there is no valve disease and left ventricular systolic function is normal and ejection fraction is 50% or more and there are echocardiographic evidence of subnormal left ventricular diastolic function (i.e. diastolic dysfunction) the patient is suffering from DHF. When the diagnosis of heart failure is itself in doubt and if facilities exist, the raised level of Brain natriuretic peptide in plasma helps to confirm the presence of heart failure.

Incipient or occult DHF – In one population based study, heart failure developed within five years in 11 to 15 percent of persons older than 65 years of age who had no clinical evidence of heart disease but had Doppler evidence of left ventricular diastolic dysfunction. Such patients might not have been pushed to heart failure had the predisposing factors like uncontrolled hypertension, atrial fibrillation, myocardial ischaemia, anaemia, renal insufficiency, use of nonsteroidal anti-inflammatory drugs or thiazolidinediones and over indulgence in salty food been taken care of.

Recently it has been pointed out that prevalence of obstructive sleep apnoea (OSA) is much higher among patients with DHF than in general population. So this syndrome of OSA can draw attention to the possibility.
Diastolic Heart Failure – Emerging Trends

of occult DHF in them and its treatment with nasal continuous positive airway pressure device (CPAP) may avert heart failure in these patients of occult diastolic dysfunction.

PATHOPHYSIOLOGY

Diastolic dysfunction is normally determined by passive elastic properties of left ventricle and by the process of active relaxation. Abnormal passive elastic properties generally are caused by a combination of increased myocardial mass and alteration of extramyocardial collagen network

A substantial number of patients with diastolic heart failure have reduced stroke volume and reduced cardiac output despite normal ejection fraction. The capacity to augment cardiac output during exercise is limited. The left ventricular size is normal but has a limited capacity to fill at a normal left atrial pressure. The left ventricular mass is increased, relative wall thickness of left ventricle is increased, end diastolic volume is normal, but end-diastolic pressure is increased and this pressure is transmitted back to left atrium and pulmonary veins, pulmonary capillaries, thereby reducing cardiac output.

A substantial number of patients with diastolic heart failure have reduced stroke volume and reduced cardiac output despite normal ejection fraction. The capacity to augment cardiac output during exercise is limited. The left ventricular size is normal but has a limited capacity to fill at a normal left atrial pressure. The left ventricular mass is increased, relative wall thickness of left ventricle is increased, end diastolic volume is normal, but end-diastolic pressure is increased and this pressure is transmitted back to left atrium and pulmonary veins, pulmonary capillaries, with resultant reduction in lung-compliance.

All these lead to exercise intolerance, exertional dyspnoea and fatigue.

Important diseases causing DHF are hypertension with increased LV mass, ischaemic heart disease, diabetes mellitus, stiff large arteries, restrictive cardiomyopathy with or without associated hypertrophy and constrictive pericarditis. (Please see table 1)

DIAGNOSIS:

Diagnosis of DHF requires i) Symptoms and signs of HF ii) normal or mildly reduced systolic left ventricular LV function and EF and iii) most importantly, evidence of LV diastolic dysfunction. High index of suspicion is sure way not to pass all heart failure cases as systolic heart failure. Patients with dyspnoea, with risk factors like hypertension, ischaemic heart disease, diabetes, old age, obesity, irregularly irregular pulse indicating atrial fibrillation (AF), auscultatory signs like 4th heart sound, chest X-ray showing pulmonary congestion with normal sized cardiac silhouette, ECG showing LVH, and left atrial enlargement should have ECHO and Doppler -Study. The ECHO and Echo-Doppler may reveal normal EF ≥50%, and diastolic dysfunction. The diagnosis of DHF may be discussed under occult DHF and overt DHF:

(i) Diagnosis of occult diastolic dysfunction is problematic. While Doppler echocardiography has aided in the diagnosis of diastolic dysfunction, altered transmitral filling pattern are ubiquitous in elderly patients. Important advances in assessment of LV diastolic dysfunction such as colour M-mode and Tissue Doppler Imaging (TDI) will probably enhance our ability to identify individuals at high risk of developing diastolic heart failure. Recent techniques to detect reduction in left atrial strain and strain rate and increase in left atrial stiffness index have predictive value for detection of occult LV diastolic dysfunction. It is thus clear that early detection of DHF in relatively asymptomatic or less symptomatic patients with occult LV diastolic dysfunction is difficult and a real challenge.

(ii) Diagnosis of overt DHF: Detecting the presence of clinical evidences of overt HF depend on of clinical acumen of physician. Proof of normal LV systolic dysfunction with normal EF (≥50%) and LV diastolic dysfunction by imaging technique is not yet available to average clinician working in periphery. Hence referral to a well trained sonologist becomes mandatory.

Doppler Echocardiography will show alteration in the E-wave velocity of blood flow into the left atrium. The authenticity of the ECHO-evidence of diastolic dysfunction has been questioned. The LV diastolic dysfunction (LVD) can be more soundly established by Tissue Doppler Imaging and invasively by cardiac catheterization. If TDI yield E/E’ ratio greater than 15 then additional echovariables like Doppler flow profile of mitral valve or pulmonary veins and measurement of LV mass index or left atrial volume index, will be needed. LV diastolic dysfunction, of course can, be authentically demonstrated invasively if cardiac catheterization shows LV diastolic pressure > 16 mm Hg or mean pulmonary capillary wedge pressure greater than 12 mm Hg. Echo-Doppler technique using LV filling pressure and TDI of the mitral annulus help in identifying and classifying degree of LV diastolic dysfunction. However clinically this is more relevant to advanced overt disease.

All said and done, the non-invasive techniques of Colour M-mode and TDI help in early recognition of diastolic dysfunction. For internists, the Echo-Doppler evidence of diastolic dysfunction suffices if the other refinements are not accessible. They should be alert to the fact that patients with obstructive sleep apnoea are more likely to have occult DHF and they should be subjected to Echo – Doppler and other non invasive imaging diagnostic technique.

Vasan et al have proposed a working diagnostic paradigm for day to day clinical practice which is shown in Table 2. The possible
Echocardiographic evidence of moderate concentric LV hypertrophy without concomitant wall motion abnormalities increases likelihood of DHF. The presence of tachyarrhythmia with shortened diastolic filling period or atrial fibrillation with resultant loss of atrial kick during episode of CHF increases the likelihood of DHF. In these settings subclinical LV diastolic dysfunction was likely unmasked by rapid heart rate. A left ventricle with normal systolic and diastolic function is unlikely to fail due to acute onset of tachycardia. Likewise, the onset of CHF by a small amount of IV fluid in a patient with normal LVEF suggests a diagnosis of DHF, because individuals with normal LV systolic and diastolic function can tolerate considerable volume load and won’t develop CHF.

If symptoms of CHF improve by lowering BP, controlling rapid heart rate or restoring atrioventricular synchrony, the diagnosis of DHF is further strengthened.

**MANAGEMENT**

The objective of treatment for DHF should be: relief of symptoms, improvement in exercise tolerance, and quality of life, reduction of hospital readmissions and improved survival.

(i) **PREVENTION of DHF**

Prevention and early treatment of coronary artery disease, hypertension, diabetes mellitus (DM), obesity and obstructive sleep apnoea will go a long way in preventing DHF.
In Initial Management

Acute manifestations of DHF will need (i) Oxygen, IV loop diuretic, morphine, SL or oral nitroglycerine or IV nitrates and oral anti hypertensive drugs for pulmonary oedema due to acute myocardial ischaemia or severe hypertension. The treatment of severe hypertension may, in exceptional cases, need IV drip of sodium nitropusside or hydralazine, ismolol etc.

Supraventricular tachycardia or atrial fibrillation with fast ventricular rate may precipitate pulmonary oedema and hypotension and should be treated urgently with synchronized electrical cardioversion. Betablockers and nondihydropyridine rate limiting calcium channel blockers can be used to prevent tachycardia or to slow the heart rate in patients with DHF.

In Long Term Management

Drug therapy: The Candesartan in Heart Failure Assessment of Reduction in Mortality (CHARM) – Preserved Study, and several short term studies of patients with CHF due to hypertensive heart disease, coronary artery disease, or both and with normal or near normal ejection fraction, have provided few guidelines for long term treatment of DHF. Of these, CHARM – Study is hitherto the best long term, randomized placebo controlled, multinational, double blind study. As many as 3023 patients aged ≥18 year with symptomatic CHF (NYHA Class – II – IV) who had left ventricular EF >40% were randomised to placebo or candesartan 32 mgm OD and followed up to 36.6 months.

Primary end points were cardiovascular (CV) death or hospital admissions for CHF.

The results were a mixed bag. There was non significant trend in reduction in CV-death in candesartan group compared to placebo group (22 vs 24.3% P = 0.118).

Secondary outcome composites of primary outcome and MI, nonfatal strokes and coronary revascularization showed insignificant reduction (402 vs 566 P = 0.014).

All cause mortality were similar in both groups (244 vs 237).

Permanent discontinuation due to adverse events or laboratory abnormalities were more frequent with candesartan (17.8 vs 13.5% P 0.001).

However, the total number of hospital admissions for CHF was significantly reduced in the candesartan group.

Another study involving patients with prior myocardial infarction, heart failure and ejection fraction >40% showed that long acting preparation of propranolol reduced the mortality in treated group. However effect on effort tolerance was not assessed in the study.

If myocardial ischaemia is contributing to DHF, then depending on finding on coronary angiogram, appropriate revascularization (PTCA or CABG) may be indicated. But high rates of recurrent DHF on patients with hypertension and CAD even after successful revascularization suggested that symptoms of DHF in these patients were not entirely due to ischamia.

TREATMENT OF HYPERTENSION

Treatment should be guided by recommendations of SHEP-trial and JNC VII. There appears to be an improvement in effort tolerance and quality of life in patients by treatment with ARBs if they had shown exaggerated BP response during stress – test.
to the tune of say, > 200 mm Hg.

**GUIDELINES FOR DRUG THERAPY**

European Society of Cardiology and American College of Cardiology and American Heart Association have issued guidelines.

These professional societies recommended the use of β-blockers (long acting e.g. carvedilol, Bisoprolol) and rate lowering calcium channel blockers if tachycardia is present, long term diureticotherapy if oedema is demonstrated and, ACE-inhibitors if hypertension with concentric LV hypertrophy is detected.

**STATUS OF DIGITALIS**

Based on the finding of trend towards reduction in hospitalizations for heart failure in patients with DHF as shown by the DIG trial, Ahmed et al recommends use of digoxin. But there is increased incidence of hospitalization for suspected toxic effects of digoxin and for unstable angina in patients treated with digoxin. Besides, due to lack of effect on all cause mortality and incomplete understanding of the mechanism whereby digoxin might exert a benefit in DHF, it may not be prudent to use digoxin yet in DHF.

Even the guidelines of American College of Cardiology/American Heart Association Task Force, state that the use of digoxin in DHF is not well established.

**PROGNOSIS**

22 – 29% patients with DHF die within one year of hospital discharge, and 65% die within five years.

In older patients with elevated pulmonary capillary wedge pressure (pulmonary hypertension) mortality is high.

**CONCLUSION**

1. DHF is diagnosed if clinical symptoms and signs of CHF are present in patients with preserved left ventricular systolic function (with EF >50%) and presence of diastolic dysfunction shown either by Echo-Doppler, Colour M-mode or by Tissue-Doppler.
2. Various prevalence studies have shown that 33% of all patients of CHF have DHF.
3. Mortality rate ranges from 5-8% annually.
4. Occult DHF: In one population based study heart failure developed in 11-15% of persons older than 65 years who had no clinical evidence of heart disease but had Doppler evidence of LV diastolic dysfunction. Prevention of DHF in such persons is discussed.
5. Drugs recommended are oxygen, loop diuretics, morphine if AMI, or pulmonary oedema are present.
6. Emergency treatment of severe hypertension in DHF is discussed.
7. Long term treatment with anti obesity – diet, salt restriction, ACE-inhibitors, ARBs, rate limiting calcium channel blockers and delayed release propranolol is discussed.
8. Roles of cardioversion, sequential AV pacing, radiofrequency ablation, PTCA and CABG in treatment of DHF are discussed.

**REFERENCES**

17. Kitzman DW, Little WC, Brubaker PH, Anderson RT et al. Pathophysiologic characterization of isolated diastolic heart failure in compari-


