Chronic heart failure

Part 1: pathophysiology and patient assessment

Significant advances in our understanding of the pathophysiology and treatment of chronic heart failure (CHF) have led to improved survival and quality of life for CHF sufferers; however, this condition remains a major cause of death and disability in our community.

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Chronic heart failure (CHF) is a common syndrome, affecting up to half a million Australians. Its prevalence is expected to increase dramatically over the next two decades, due both to the ageing of the population and to improved survival of individuals with ischaemic heart disease and hypertension – the two major antecedents of CHF in the Australian community. In addition, the emerging 'epidemic' of type 2 diabetes mellitus and its associated cardiovascular morbidities is likely to add considerably to the burden of CHF.

CHF can occur at any age, but most affected individuals are elderly; about half are over the age of 75 years. Heart failure is the single most common indication for hospitalisation in people over the age of 65 years. One of the major challenges facing the Australian healthcare system is how to manage successfully the growing burden of CHF, particularly in the frail elderly population.

The first part of this two-part article reviews the aetiology and pathophysiology of CHF and the assessment of patients suspected of having this condition. The second part of this article, to be published in the July issue of *Medicine Today*, discusses the therapeutic options for patients with established CHF and preventive strategies.

Aetiology

As mentioned above, systemic hypertension and ischaemic heart disease are the two most common antecedent cardiovascular diseases in patients with CHF. One or both of these conditions is present in 80 to 90% of patients with CHF.

Diabetes mellitus and chronic atrial fibrillation are two common comorbidities with heart failure, each being present in up to one-third of CHF patients. Both conditions are likely to contribute to the progression of CHF.

IN SUMMARY

- **Clinically, chronic heart failure (CHF) is a syndrome of dyspnoea, fatigue or exercise intolerance due to systolic or diastolic cardiac dysfunction.**
- **It is associated with a complex pattern of neurohormonal activation that results in fluid retention and vasoconstriction.**
- **While dyspnoea and fatigue are the cardinal symptoms of CHF, orthopnoea, paroxysmal nocturnal dyspnoea and ankle swelling strengthen the clinical suspicion of heart failure.**
- **Many patients with CHF have few clinical signs; a displaced apex beat is probably the single most reliable physical abnormality indicating cardiomegaly.**
- **All patients with suspected heart failure should undergo standard investigations comprising blood tests, ECG and chest x-ray; those with a clinical diagnosis of heart failure should have an echocardiogram.**

Valvular heart disease is estimated to be the underlying cause or a significant contributor to heart failure in 10 to 20% of cases. Of particular importance is valvular aortic stenosis. This is a potentially curable cause of heart failure, its incidence increases with age, and the characteristic physical findings may be masked by low cardiac output together with age-related arterial changes.

Cardiomyopathies also cause CHF. These have been classified as dilated, restrictive or hypertrophic. CHF is the common clinical manifestation of the dilated and restrictive forms of cardiomyopathy, but is seen less often in hypertrophic cardiomyopathy. Although hypertrophic cardiomyopathy has been recognised for some time as being an inherited disorder, it is now apparent that up to one-third of cases of dilated and some cases of restrictive cardiomyopathy are also due to an inherited gene defect. Thus family screening should be considered in all patients presenting with 'idiopathic' dilated or restrictive cardiomyopathy.

Other causes of CHF include:

- metabolic and endocrine disorders
- drugs of abuse (e.g. alcohol and cocaine)
- prescribed drugs (e.g. anthracyclic anticancer agents)
- pericardial disease
- congenital heart disease.

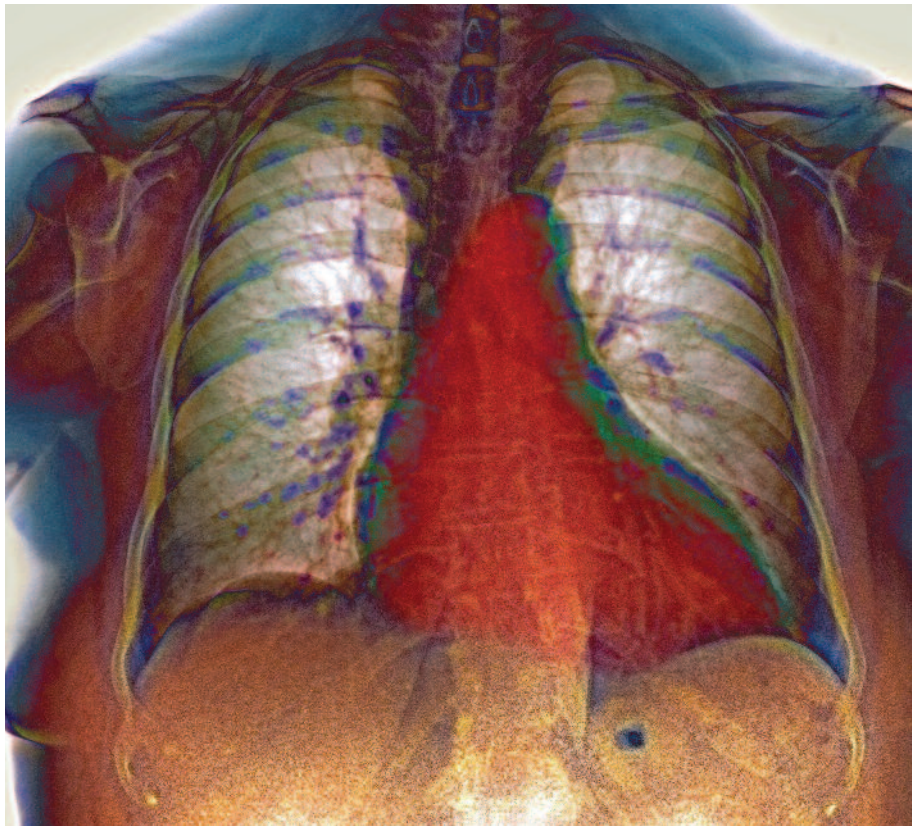

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Figure. Coloured chest x-ray of a patient with cardiomegaly.

Pathophysiology

An inability of the heart to deliver sufficient blood to meet the metabolic requirements of the body in the presence of an adequate intracardiac filling pressure is the essential pathophysiological basis for heart failure. This may be caused by impaired ventricular emptying (i.e. systolic failure) or impaired ventricular filling (i.e. diastolic failure). In many cases, both systolic and diastolic dysfunction occur together.

Systolic versus diastolic heart failure

A left ventricular ejection fraction (LVEF) of 40% is used by most investigators to distinguish patients with systolic CHF (LVEF <40%) from those with diastolic CHF (LVEF ≥40%); however, this distinction is somewhat arbitrary. Diastolic CHF is sometimes described as CHF with preserved systolic function. Importantly, the evidence base for the treatments that have been shown to improve survival in CHF has only been obtained in patients with systolic CHF. On the other hand, observational comparisons between patients with systolic and diastolic CHF have uniformly reported better survival in patients with diastolic CHF.

Systolic and diastolic CHF cannot be reliably distinguished based on clinical manifestations or simple investigations such as the chest x-ray and ECG. Although ischaemic heart disease is classically associated with systolic heart failure and hypertension with diastolic heart failure, there is a large overlap between these disease processes and the type of CHF that they produce. Echocardiography is the simplest investigation to distinguish systolic from diastolic CHF.

Neurohormonal activation

Irrespective of being due to systolic or diastolic ventricular dysfunction, heart failure is typically associated with a complex pattern of activation of the sympathetic nervous system and various hormonal systems. Some of these hormonal

Table 1. Acute precipitants of heart failure

- Noncompliance with drug therapy or diet: missed medication for heart failure, excess dietary salt
- Acute myocardial ischaemia/ infarction
- New onset arrhythmia
- Intercurrent infection (particularly pulmonary)
- New drug therapies, including those with negative inotropic properties (e.g. beta blockers, some calcium antagonists, some antiarrhythmic drugs) or those that cause fluid retention (e.g. NSAIDs)
- Acute pulmonary embolism
- Anaemia
- Thyrotoxicosis

systems (e.g. the renin–angiotensin–aldosterone system, vasopressin and endothelin) are antinatriuretic and vasoconstrictory, whereas others (e.g. atrial and brain natriuretic peptides [ANP and BNP, respectively] and prostacyclin) are natriuretic and vasodilatory. The net result is a state of systemic vasoconstriction and fluid retention; this maladaptive response contributes to the progressive nature of CHF as follows:

- systemic vasoconstriction increases left ventricular afterload, which leads to a further decline in cardiac output despite an increase in myocardial work
- sodium and fluid retention increases ventricular diastolic pressure; this reduces subendocardial blood flow and leads to a further decline in ventricular function.

Cardiac myocyte hypertrophy, myocyte apoptosis, myocardial fibrosis, and increased arrhythmogenesis are some of the long term consequences of neurohormonal activation that undoubtedly contribute to the progression of CHF and its mortality.

Generally, the activation of each neurohormonal system is proportional to the CHF severity; however, some neurohormones are more sensitive markers of left ventricular dysfunction than others. The natriuretic peptides, particularly BNP, have been shown to be very sensitive indicators of CHF. Commercial assays for plasma BNP and the inactive N-terminal peptide (nt-proBNP) that is cleaved from its precursor have been developed as simple blood tests for the detection of CHF. In addition, plasma BNP has been shown to be elevated in proportion to the symptomatic severity of CHF and to be an independent predictor of mortality in patients with this condition.

Acute versus chronic heart failure

Heart failure may occur as an acute syndrome precipitated by factors such as extensive acute myocardial infarction or viral myocarditis that lead to sudden impairment of both systolic and diastolic function. Further complications such as arrhythmias or cardiac muscle rupture may lead to abrupt deterioration and often catastrophic heart failure.

More often, heart failure presents as a chronic syndrome. In patients with CHF long term structural changes have occurred in the heart (resulting in left ventricular remodelling), lungs, skeletal muscle and peripheral vasculature. Patients with CHF usually have stable symptoms while they take appropriate treatment, but they may present with acute deterioration. An acute precipitating factor should always be sought in patients presenting this way (Table 1).

Clinical assessment of suspected heart failure

In the assessment of patients with suspected heart failure, the following questions should be answered:

- Are the patient's symptoms and signs due to heart failure?
- What is the underlying process that has led to heart failure?
- What is the precipitating event that has led to the patient presenting at this time?

The combination of data derived from the clinical history, examination and standard investigations should enable the clinician to answer these questions. The diagnostic algorithm shown on page 53 is that currently recommended by the National Heart Foundation and the Cardiac Society of Australia and New Zealand.[1]

Clinical history

The cardinal symptoms of CHF are dyspnoea and fatigue; however, they are nonspecific symptoms that are often found in other conditions such as respiratory disease, obesity or anaemia. Orthopnoea and paroxysmal nocturnal dyspnoea (symptoms of pulmonary venous congestion) and ankle swelling

Table 2. New York Heart Association Classification of CHF

Class	Symptoms	One-year mortality*
I	None, asymptomatic left ventricular dysfunction	5%
II	Dyspnoea or fatigue on moderate physical exertion	10%†
III	Dyspnoea or fatigue on normal daily activities	10 to 20%†
IV	Dyspnoea or fatigue at rest	40 to 50%†

* Approximate values derived from placebo-controlled trials. † Most studies of symptomatic heart failure have

(systemic congestion) strengthen the clinical suspicion of heart failure, but they may be absent in patients with CHF.

A history of ischaemic heart disease (i.e. angina, previous myocardial infarction, coronary revascularisation and coronary risk factors) should be sought in all patients. Hypertension is a major risk factor for ischaemic heart disease and an independent cause of heart failure. Roughly 40% of all patients with heart failure have a history of both hypertension and ischaemic heart disease, and about 20% have an antecedent history of diabetes mellitus.

Valvular heart disease is suggested by a history of rheumatic fever or a long-standing heart murmur.

Patients with suspected cardiomyopathy should be asked about a prodromal viral illness (myocarditis). In addition, they should be asked about excessive alcohol intake and drug exposure (both prescribed and abused). A family history of cardiomyopathy should also be explored. Close examination of family pedigrees of patients with idiopathic dilated cardiomyopathy reveals other affected members in up to one-third of cases.

Patients with established heart failure who present with an acute exacerbation should be asked about compliance with drug and diet therapy and changes to concomitant drug therapy (e.g. addition of an NSAID to the regimen). Other well-recognised precipitants include infections of any type, new myocardial ischaemia or infarction and arrhythmias (especially new onset of atrial fibrillation). Sometimes, intractable arrhythmias such as sustained rapid atrial fibrillation or flutter may produce heart failure in the absence of any underlying structural heart disease – the so-called tachycardia-induced cardiomyopathy.

Symptoms of heart failure may vary considerably in the extent to which they limit a patient's functional capacity. The New York Heart Association (NYHA) classification is widely used to grade symptomatic severity and functional limitation in patients with CHF (Table 2). This classification has prognostic significance in that patient survival is inversely related to NYHA class.

Physical examination

Many patients with CHF have few or subtle clinical signs. A displaced cardiac apex beat is probably the single most reliable physical abnormality, indicating cardiomegaly; however, while this has high

Diagnostic algorithm for chronic heart failure

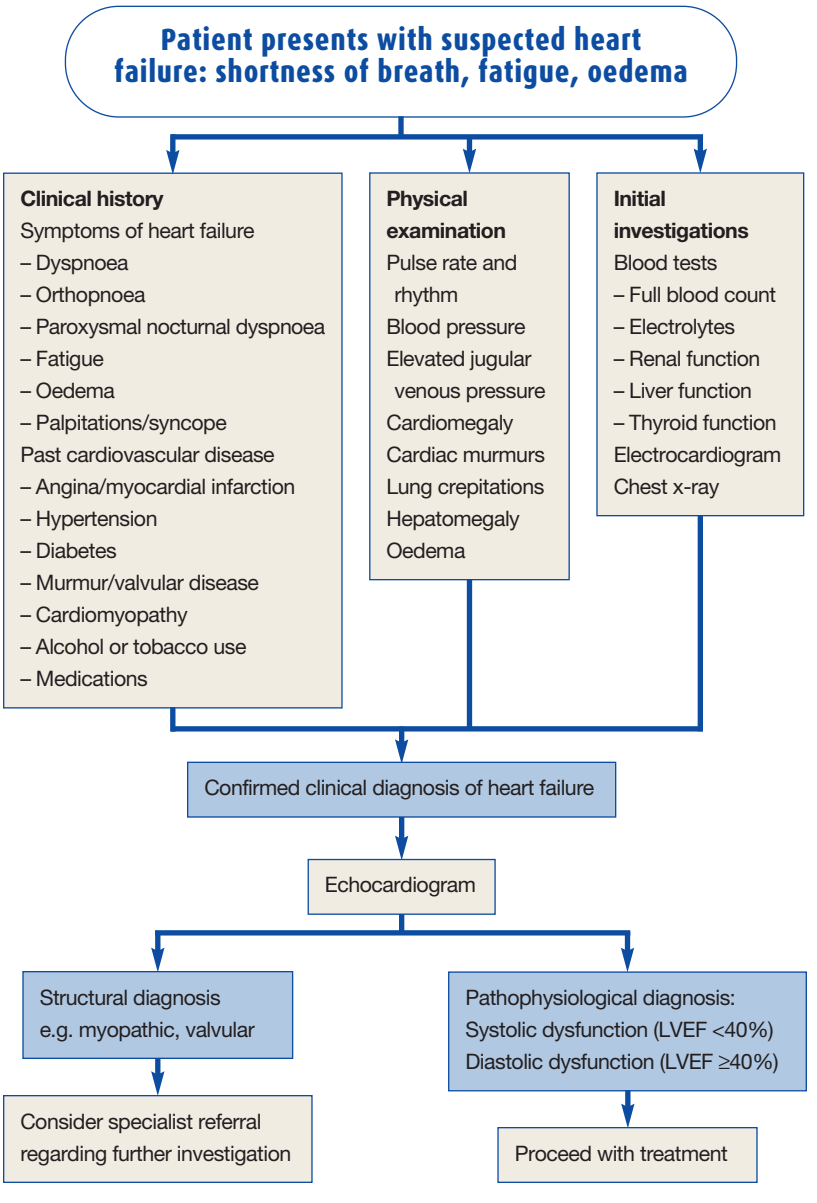

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Table 3. Interpreting ECG findings

ECG finding	Interpretation
Normal	Suggests another explanation for the patient's symptoms
Pathological Q waves	Indicates previous myocardial infarction and ischaemic heart disease; occasionally seen in cardiomyopathy
Bundle branch block	Suggests extensive myocardial disease
Left ventricular hypertrophy	Indicates hypertension, aortic stenosis or hypertrophic cardiomyopathy
Low QRS voltages	Suspect infiltrative cardiomyopathy, such as amyloidosis or pericardial disease (constriction or effusion)
Atrial fibrillation	Present in about one-third of all heart failure patients; acute onset of atrial fibrillation may cause acute deterioration
Bradyarrhythmias	Heart block may cause acute deterioration

specificity, it has low sensitivity. Echocardiography has shown us that marked left ventricular dilatation can occur without clinical or radiological displacement of the cardiac apex. The presence of a third heart sound, with or without pansystolic murmurs (due to mitral and tricuspid regurgitation), further supports the CHF diagnosis.

In patients with more advanced heart failure or those with acute decompensation, signs of neurohormonal activation (e.g. peripheral vasoconstriction and tachycardia) and fluid retention (e.g. elevated jugular venous pressure, lung crackles, hepatomegaly and peripheral oedema) are often seen. In those with mild heart failure or those who have been stabilised on treatment, these signs may be completely absent.

The pulse rate and rhythm should be recorded in all patients. Between 20 and 30% of patients with CHF are also in chronic atrial fibrillation. Blood pressure is usually normal or low for the patient's age unless systemic hypertension is also present.

It is important that signs of specific cardiac valvular defects are always sought. However, in the setting of heart failure, particularly in the elderly, murmurs and other cardiovascular findings that are characteristic of these lesions may be less clear. Aortic stenosis is a classic example of this; the murmur may be faint or absent in patients with severe heart failure.

Patients with diastolic heart failure may also have signs of pulmonary or systemic venous congestion. The heart may or may not be enlarged. In these patients, the cardiomegaly usually reflects atrial rather than ventricular dilatation. Diastolic heart failure is particularly prevalent in elderly women and patients with hypertension; however, as mentioned earlier, there is no clinical symptom or sign that clearly distinguishes diastolic from systolic heart failure.

Investigations

The aims of investigations for heart failure are to:

- establish the underlying cardiac diagnosis
- identify any precipitating events
- assess severity and the patient's prognosis
- provide a baseline from which to measure therapeutic response.

Standard investigations that should be performed in all patients with suspected heart failure are shown in the algorithm on page 53. Additional investigations that may then be indicated include the following:

- nuclear cardiac imaging
- cardiac catheterisation
- coronary angiography
- endomyocardial biopsy
- investigations relevant to specific forms of cardiomyopathy.

The ECG is rarely normal in patients with heart failure, regardless of the cause; thus, a normal ECG suggests an alternate diagnosis (Table 3).

As mentioned above, simple blood tests for plasma BNP and the n-terminal fragment of its precursor (nt-proBNP) have been developed and are clinically available. The clinical role of these tests in patients with suspected heart failure is still being defined; however, given the simplicity of the assays, it is likely that their use will increase, both as simple screening tests and as methods of monitoring the clinical course and response to treatment of patients with established heart failure.

Echocardiography is a particularly useful investigation that, arguably, should be performed in all patients with a clinical diagnosis of heart failure. This investigation provides information on the cause, pathophysiology (systolic or diastolic dysfunction) and severity (degree of ventricular dilatation, hypertrophy and dysfunction) of the heart failure. In addition, it is harmless and relatively painless.

When to refer to the specialist

Generally, all patients with suspected heart failure should be referred to a specialist physician or cardiologist for diagnostic evaluation and initial advice about treatment. The role of the specialist includes:

- identifying the small percentage of patients who will benefit from cardiac surgery (usually coronary bypass surgery or valvular surgery)
- identifying those patients who require

or will benefit from implantation of a biventricular pacemaker and/or implantable defibrillator
- advising the GP on optimal drug therapy
- co-ordinating a multidisciplinary management plan with the GP and allied health personnel.

Most patients with CHF have several other chronic illnesses, each of which is subject to episodic acute exacerbations. Optimal management of patients with CHF is probably best achieved by a shared care approach between the GP and a heart failure nurse specialist. Indeed, there is increasing evidence that care is optimised and both the risk of acute deterioration and need for hospitalisation minimised by a multidisciplinary team approach involving the GP, nurse specialist, pharmacist, physiotherapist, occupational therapist, dietician and social worker.

Conclusions

Although there have been advances in our understanding of the pathophysiology of heart failure and its treatment, the overall prognosis of patients with CHF remains poor. With the proportion of elderly patients in our community expected to increase steadily over the next two decades, CHF is likely to become a major epidemic. Therapeutic options available for patients with established heart failure and strategies for preventing this disease will be reviewed in the second part of this article in July's issue of *Medicine Today*. MT

Reference

1. National Heart Foundation and Cardiac Society of Australia and New Zealand. Guidelines on the contemporary management of the patient with chronic heart failure in Australia. 2002. Available at: www.heartfoundation.com.au/downloads/cont.management.pdf

DECLARATION OF INTEREST: None.