

1 History and epidemiology

**“The very essence of cardiovascular practice is the early detection of heart failure”
Sir Thomas Lewis, 1933**

Heart failure is the end stage of most diseases of the heart and is a major cause of morbidity and mortality. It is estimated to account for about 5% of admissions to hospital medical wards, with over 100 000 annual admissions in the UK.

The overall prevalence of heart failure in the West Midlands region of England in the late 1990s, using objective criteria for diagnosis, was at least 2.3% in those aged ≥ 45 , with a marked increase in prevalence with advancing age. The annual incidence of heart failure is 1–3 per 1000, and the relative incidence doubles for each decade of life after the age of 45. The overall prevalence is likely to increase in the future because of an ageing population and therapeutic advances in the management of acute myocardial infarction and established heart failure leading to improved survival in patients with impaired cardiac function.

Unfortunately, heart failure can be difficult to diagnose clinically as many features of the condition are not organ specific and there may be few clinical features in the early stages of the disease. Recent advances have made the early recognition of heart failure increasingly important as modern drug treatment has the potential to improve symptoms and quality of life, reduce rates of admission to hospital, slow the rate of disease progression, and improve survival. In addition, coronary revascularisation and heart valve surgery are now regularly performed, even in elderly patients.

A brief history

Descriptions of heart failure exist from ancient Egypt, Greece, and India, and the Romans were known to use the foxglove as medicine. Little understanding of the nature of the condition can have existed until William Harvey described the circulation in 1628. Röntgen’s discovery of x rays and Einthoven’s development of electrocardiography in the 1890s led to improvements in the investigation of heart failure. The development of echocardiography, cardiac catheterisation, and nuclear medicine has since improved the diagnosis and investigation of patients with heart failure. Blood letting and leeches were used as treatment for centuries, and William Withering published his account of the benefits of digitalis in 1785.

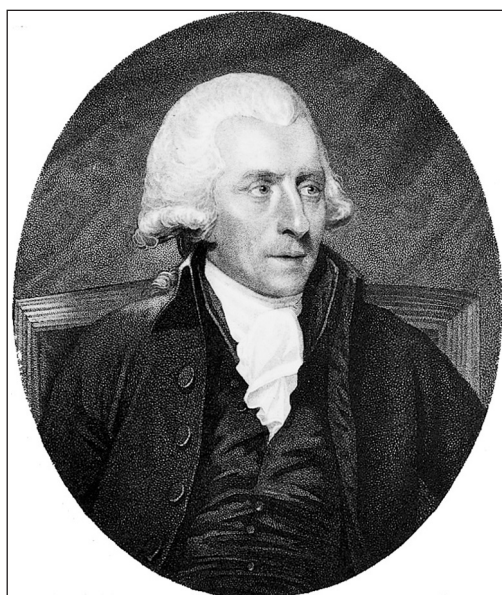


The foxglove was used as a medicine in heart disease as long ago as Roman times. Reproduced with permission from the Fine Arts Photographic Library

Some definitions of heart failure

- A condition in which the heart fails to discharge its contents adequately (Thomas Lewis, 1933)
- A state in which the heart fails to maintain an adequate circulation for the needs of the body despite a satisfactory filling pressure (Paul Wood, 1950)
- A pathophysiological state in which an abnormality of cardiac function is responsible for the failure of the heart to pump blood at a rate commensurate with the requirements of the metabolising tissues (E Braunwald, 1980)
- Heart failure is the state of any heart disease in which, despite adequate ventricular filling, the heart’s output is decreased or in which the heart is unable to pump blood at a rate adequate for satisfying the requirements of the tissues with function parameters remaining within normal limits (H Denolin, H Kuhn, H P Kravenbuehl, F Loogen, A Reale, 1983)
- A clinical syndrome caused by an abnormality of the heart and recognised by a characteristic pattern of haemodynamic, renal, neural, and hormonal responses (Philip Poole-Wilson, 1985)
- [A] syndrome . . . which arises when the heart is chronically unable to maintain an appropriate blood pressure without support (Peter Harris, 1987)
- A syndrome in which cardiac dysfunction is associated with reduced exercise tolerance, a high incidence of ventricular arrhythmias, and shortened life expectancy (Jay Cohn, 1988)
- Abnormal function of the heart causing a limitation of exercise capacity or “ventricular dysfunction with symptoms (anonymous and pragmatic)
- Symptoms of heart failure, objective evidence of cardiac dysfunction, and response to treatment directed towards heart failure (Task Force of the European Society of Cardiology, 1995)

Adapted from Poole-Wilson PA, et al, eds, *Heart failure* New York: Churchill Livingstone, 1997:270)



In 1785 William Withering of Birmingham published an account of the medicinal use of digitalis. Reproduced with permission from the Fine Arts Photographic Library

ABC of heart failure

In the 19th and early 20th centuries, heart failure associated with fluid retention was treated with Southey's tubes, which were inserted into oedematous peripheries, allowing some drainage of fluid.

It was not until the 20th century that diuretics were developed. The early, mercurial agents, however, were associated with substantial toxicity, unlike the thiazide diuretics, which were introduced in the 1950s. Vasodilators were not widely used until the development of angiotensin converting enzyme inhibitors in the 1970s. The landmark CONSENSUS-I study (first cooperative north Scandinavian enalapril survival study), published in 1987, showed the unequivocal survival benefits of enalapril in patients with severe heart failure. The benefits of β blockers were established in the 1990s, and subsequently aldosterone antagonists and device therapy (resynchronisation therapy and implantable defibrillators) are becoming established treatments.

Epidemiology

Studies of the epidemiology of heart failure have been complicated by the lack of universal agreement on a definition of heart failure, which is primarily a clinical diagnosis. National and international comparisons have therefore been difficult, and mortality data, postmortem studies, and hospital admission rates are not easily translated into incidence and prevalence. Several different systems have been used in large population studies, with the use of scores for clinical features determined from history and examination, and, in most cases, chest radiography to define heart failure.

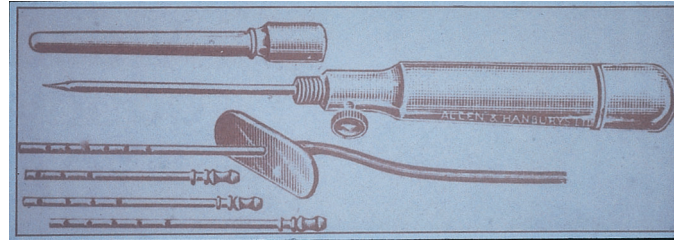
The Task Force on Heart Failure of the European Society of Cardiology has published guidelines on the diagnosis of heart failure, which require the presence of symptoms and objective evidence of cardiac dysfunction. Reversibility of symptoms on appropriate treatment is also desirable. Echocardiography is recommended as the best way of assessing cardiac function, and this investigation has been used in more recent studies.

In the Framingham heart study a cohort of 5209 participants has been assessed biennially since 1948, with a further cohort (their offspring) added in 1971. This uniquely large dataset has been used to determine the incidence and prevalence of heart failure, defined with consistent clinical and radiographic criteria.

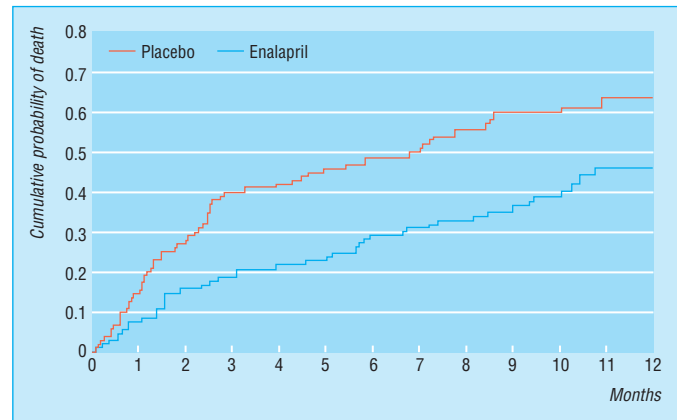
Several UK studies of the epidemiology of heart failure and left ventricular dysfunction have been conducted, including a study of the incidence of heart failure in one west London district (Hillingdon heart failure study) and large prevalence studies in Glasgow (north Glasgow monitoring trends and determinants in cardiovascular disease (MONICA) study) and the West Midlands ECHOES (echocardiographic heart of England screening) study. Epidemiological studies of heart failure have used different levels of ejection fraction to define systolic dysfunction. The Glasgow study, for example, used an ejection fraction of 30% as its criterion, whereas most others have used levels of 40–45%. The prevalence of heart failure seems similar in many different surveys, however, despite variation in the levels of ejection fraction, and this observation is not entirely explained.

Prevalence of heart failure

During the 1980s, the Framingham study reported the age adjusted overall prevalence of heart failure, with similar rates for men and women. Prevalence increased dramatically with increasing age, with an approximate doubling in the prevalence of heart failure with each decade of ageing.



Southey's tubes were at one time used for removing fluid from oedematous patients



Mortality curves from the CONSENSUS-I study

European Society of Cardiology criteria for diagnosis of heart failure

- To satisfy the diagnosis of heart failure there must be:
 - Appropriate symptoms
 - Objective evidence of cardiac dysfunction and (in cases of doubt) Appropriate response to relevant treatment
- Echocardiography is the most practical tool to demonstrate cardiac dysfunction

The Framingham heart study has been the most important longitudinal source of data on the epidemiology of heart failure

Methods of assessing prevalence of heart failure in published studies

- Clinical and radiographic assessment
- Echocardiography
- General practice monitoring
- Drug prescription data

The MONICA study is an international study conducted under the auspices of the World Health Organization to monitor trends in and determinants of mortality from cardiovascular disease

History and epidemiology

In Nottinghamshire, the prevalence of heart failure in 1994 was estimated from prescription data for loop diuretics and examination of the general practice notes of a sample of these patients to determine the number who fulfilled predetermined criteria for heart failure. The overall prevalence of heart failure was estimated as 1.0% to 1.6%, rising from 0.1% in those aged 30–39 to 4.2% at 70–79 years. This method, however, may exclude individuals with mild heart failure and include patients treated with diuretics who do not have heart failure.

In the ECHOES study left ventricular systolic dysfunction was diagnosed in 1.8% of the 3960 participants, but half had no symptoms. Definite heart failure was seen in 2.3% and was associated with an ejection fraction of <40% in 41% of patients, atrial fibrillation in 33%, and valve disease in 26%. In total, 3.1% patients aged ≥45 had definite or probable heart failure.

Incidence of heart failure

The Framingham data show an age adjusted annual incidence of heart failure of 0.14% in women and 0.23% in men. Survival in women is generally better than in men, leading to the same point prevalence. There is an approximate doubling in the incidence of heart failure with each decade of ageing, reaching 3% in those aged 85–94 years.

The recent Hillingdon study examined the incidence of heart failure, defined on the basis of clinical and radiographic findings, with echocardiography in a population in west London. The overall annual incidence was 0.08%, rising from 0.02% at age 45–55 to 1.2% at age ≥86. About 80% of these patients received the first diagnosis after acute hospital admission, with only 20% being identified in general practice and referred to a dedicated clinic.

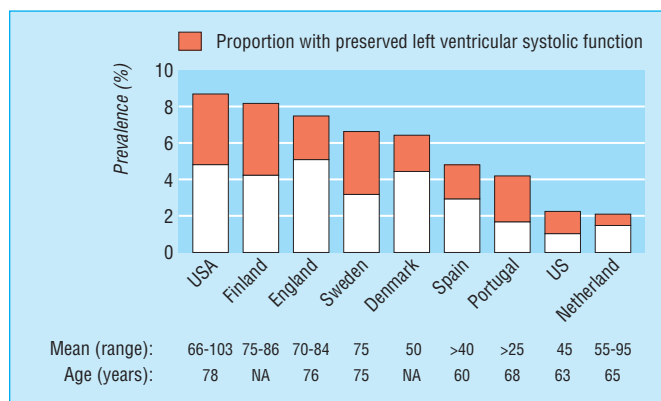
The Glasgow group of the MONICA study and the ECHOES group have found that coronary artery disease is the most powerful risk factor for impaired left ventricular function, either alone or in combination with hypertension. In these studies, hypertension alone did not seem to contribute substantially to impairment of left ventricular systolic contraction, though the Framingham study did report a more substantial contribution from hypertension. This apparent difference between the studies may reflect improvements in the treatment of hypertension and the fact that some patients with hypertension, but without coronary artery disease, may develop heart failure as a result of diastolic dysfunction.

Prevalence of left ventricular dysfunction

Large surveys were carried out in Britain in the 1990s, in Glasgow and the West Midlands, using echocardiography. In Glasgow the prevalence of significantly impaired left ventricular contraction in people aged 25–74 was 2.9%; in the West Midlands, the prevalence was 1.8% in those aged ≥45. The higher rates in the Scottish study may reflect the high prevalence of ischaemic heart disease, the main precursor of impaired left ventricular function in both studies. The numbers of symptomatic and asymptomatic cases were about the same in both studies.

Ethnic differences

Ethnic differences in the incidence of and mortality from heart failure have also been reported. In the US, African-American men have been reported as having a 33% greater risk of being



Prevalence of heart failure in cross sectional population echocardiographic studies and proportion of patients with preserved left ventricular systolic function. Adapted from McMurray JJ, Pfeffer MA. *Lancet* 2005;365:1877–89

Prevalence (percentage) of ejection fraction <40% and 40–50% by age and sex in the ECHOES study

	Male	Female	Total
<i>Ejection fraction <40%</i>			
Age (years):			
45–54	4/633 (0.6)	0/681	4/1314 (0.3)
55–64	19/623 (3.0)	3/571 (0.5)	22/1194 (1.8)
65–74	23/480 (4.8)	5/472 (1.1)	28/952 (2.9)
75–84	10/205 (4.9)	6/229 (2.6)	16/434 (3.7)
≥85	2/23 (8.7)	0/43	2/66 (3.0)
Total	58/1964 (3.0)	14/1996 (0.7)	72/3960 (1.8)
<i>Ejection fraction 40–50%</i>			
Age (years):			
45–54	8/633 (1.3)	9/681 (1.3)	17/1314 (1.3)
55–64	25/623 (4.0)	17/571 (3.0)	42/1194 (3.5)
65–74	32/480 (6.7)	13/472 (2.8)	45/952 (4.7)
75–84	13/205 (6.3)	13/229 (5.7)	26/434 (6.0)
≥85	3/23 (13.0)	6/43 (14.0)	9/66 (13.6)
Total	81/1964 (4.1)	58/1996 (2.9)	139/3960 (3.5)

Adapted from Davies MK, et al. *Lancet* 2001;358:439–44

About half of the patients with measurable left ventricular dysfunction in the Glasgow and West Midlands studies had no symptoms and therefore would be difficult to identify at this relatively early stage by clinical examination—underscoring the need for echocardiography

In the US mortality from heart failure at age <65 has been reported as being up to 2.5-fold higher in black patients than in white patients

ABC of heart failure

admitted to hospital for heart failure than white men; the risk for black women was 50% greater.

A similar picture emerged in a survey of heart failure among acute medical admissions to a city centre teaching hospital in Birmingham. The commonest underlying aetiological factors were coronary heart disease in white patients, hypertension in black Afro-Caribbean patients, and coronary heart disease and diabetes in Indo-Asians. Some of these racial differences may be related to the higher prevalence of hypertension and diabetes in black people and coronary artery disease and diabetes mellitus in Indo-Asians.

At eight years' follow-up of admissions for acute heart failure to a city centre hospital serving a multiethnic population, the total mortality was 90.5% among Europeans and 87.0% among non-Europeans (log rank test, $P = 0.0705$). The non-European patients had significantly better survival at all time points until six years, after which the survival curves start to converge.

Summary of relative importance of aetiological factors by ethnic group based on available evidence

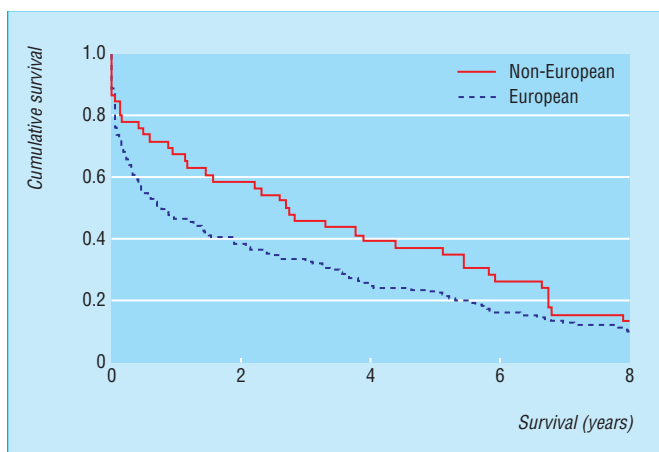
	White European	Black	South Asian
Ischaemic heart disease	+++	+	+++
Diabetes	++	+++	+++
Hypertension	++	+++	+
Atrial fibrillation	++	+	+
Dilated cardiomyopathy	+	++	No data
Increasing age	+++	++	++
Access to care	-	+	+

(+ = some importance, +++ = great importance)
Adapted from Sosin MD, et al. *Eur J Heart Fail* 2004;6:831-43

Impact on health services

Heart failure accounts for at least 5% of admissions to general medical and geriatric wards in British hospitals, and admission rates for heart failure in various European countries (Sweden, Netherlands, and Scotland) and in the US doubled between the 1980s and 1990s, although this increase has now levelled off. Furthermore, heart failure accounts for about 1.9% of the total healthcare expenditure in the UK, most of these costs being related to hospital admissions. The cost of heart failure is increasing, with an estimated UK expenditure in 2000 of £905m. "Indirect" costs (for example, on nursing home care) are equivalent to a further 2% of the NHS budget.

Hospital readmissions and general practice consultations often occur soon after the diagnosis of heart failure. In elderly patients with heart failure, readmission rates range from 29-47% within three to six months of the initial hospital discharge. Treating patients with heart failure with angiotensin converting enzyme inhibitors can reduce the overall cost of treatment (because of reduced hospital admissions), despite increased drug expenditure and improved long term survival.



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Further reading

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