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# Heart failure diagnosis and investigation

See also the separate [Heart Failure Management](#), [Cardiac Rehabilitation](#) and [Palliative Care of Heart Failure](#) articles.

Heart failure is a clinical syndrome resulting in a reduced cardiac output and/or elevated intracardiac pressures at rest or during stress. characterised by:

- Typical symptoms: shortness of breath, fatigue, ankle swelling.
- Typical signs: tachycardia, tachypnoea, pulmonary rales, [pleural effusion](#), [raised jugular venous pressure \(JVP\)](#), [peripheral oedema](#), [hepatomegaly](#).
- Objective evidence of a structural or functional abnormality of the heart at rest: cardiomegaly, third heart sound, cardiac murmurs, echocardiogram abnormalities, raised natriuretic peptide concentration.

The European Society of Cardiology (ESC) guidelines require that there be symptoms, signs and objective evidence present before a diagnosis of heart failure can be made.<sup>[1]</sup> Heart failure has a number of different aetiologies (see 'Aetiology', below) - always try to determine the cause. Heart failure should never be the only diagnosis, as it is a syndrome occurring as a result of other diagnostic entities.

## Classification of heart failure

### Acute and chronic

Heart failure has traditionally been described as [acute heart failure](#) or chronic heart failure, but this can be confusing and should be used to describe time, rather than severity. Acute heart failure can present as new-onset heart failure in people without known cardiac dysfunction, or as acute decompensation of chronic heart failure.

NICE divides heart failure into two entities in this way, with separate guidelines for acute and chronic heart failure.<sup>[2]</sup> <sup>[3]</sup> The first is essentially aimed at an acute admission in secondary care, whereas the second concentrates more on diagnosis of the longer-standing condition in primary care and referral on to a specialist secondary care service, and the subsequent management there and follow-up in the community. The ESC guideline addresses acute and chronic heart failure together within one document.<sup>[1]</sup>

## **Ejection fraction**<sup>[1]</sup> <sup>[3]</sup>

The left ventricular ejection fraction (LVEF) is the percentage of the blood in the left ventricle which is pumped out with each heartbeat. It is measured on transthoracic echocardiography, and also can be assessed by MRI, transoesophageal echocardiography and nuclear medicine scans.

Heart failure has been grouped by severity based on the measurement of left ventricular ejection fraction (LVEF). This was based on the original treatment trials in heart failure that demonstrated substantially improved outcomes in patients with LVEF above 40%. The European Society of Cardiology heart failure guideline uses the following classification of heart failure:

- Reduced LVEF (HFrEF): 40% or less; significant reduction in LV systolic function.
- Mildly reduced LV systolic function (HFmrEF): LVEF between 41% and 49%.
- Preserved ejection fraction (HFpEF): 50% or higher.

Heart failure is divided into:

- Heart failure with reduced ejection fraction : defined as heart failure with an ejection fraction less than 40%.
- Heart failure with preserved ejection fraction . Usually relaxation rather than contraction of the left ventricle is affected, and ejection fraction is normal or at least above 40%.

- The ESC guidelines also define a heart failure with mid-range ejection fraction (HFmrEF) of 40–49%, which they consider a grey area where normal ejection fraction is 50 or more. The definition of normal varies somewhat between experts, but NICE and the ESC guidelines agree on the 40% cut off for reduced vs preserved ejection fraction definitions.

This distinction is clinically important, as the two main types of heart failure are representative of different causes, demographics and comorbidities, and most importantly treatment is different.

### **Other classifications**

Other terms have been used in the past but are no longer in use. High vs low output failure has been replaced by ejection fraction terms. Systolic and diastolic failure are similarly no longer used. Classification by severity of symptoms is discussed in the 'Staging' section later, although symptom severity does not necessarily correlate with assessment of left ventricular function.

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## **Epidemiology**<sup>[3]</sup> <sup>[4]</sup>

The prevalence of heart failure increases with age. The average age at first diagnosis is 76 years. In the UK, the prevalence of heart failure is estimated to be about:

- 1 in 35 people 65–74 years of age.
- 1 in 15 people 75–84 years of age.
- Just over 1 in 7 people 85 years of age or older.

The incidence of heart failure in Europe is about 5 per 1,000 person/years in adults, and the prevalence is 1–2% in adults (1% for those under 55 years, and more than 10% for those aged over 70 years).

In people with heart failure, about 50% have reduced ejection fraction and 50% have preserved or mildly reduced ejection fraction.

Heart failure accounts for about 2% of all NHS hospitalised bed-days, and 5% of all NHS medical emergency admissions.

# Aetiology

Coronary heart disease and hypertension are the most common causes of heart failure in the UK.

- Valvular heart disease:
  - [Aortic stenosis](#) can cause left ventricular hypertrophy (LVH) due to chronic excessive afterload.
  - [Aortic regurgitation](#) or [mitral regurgitation](#), [atrial septal defect \(ASD\)](#), [ventricular septal defect \(VSD\)](#) and [tricuspid incompetence](#) cause excessive preload.
- Heart failure secondary to myocardial disease:
  - Coronary heart disease ([myocardial infarction \(MI\)](#) and ischaemia, arrhythmias - eg, [atrial fibrillation \(AF\)](#), heart block).
  - [Hypertension](#) (increased vascular resistance, often with LVH but preserved ejection fraction).
  - [Cardiomyopathies](#).
  - Drugs - eg, beta-blockers, calcium antagonists, anti-arrhythmics, cytotoxics.
  - Toxins - eg, alcohol, cocaine, mercury, cobalt, arsenic.
  - Endocrine - eg, [diabetes](#), [hypothyroidism](#), [hyperthyroidism](#), [Cushing's syndrome](#), [adrenal insufficiency](#), [excessive growth hormone](#), [phaeochromocytoma](#).
  - Nutritional - eg, deficiencies of thiamine, selenium, carnitine, and obesity, cachexia.
  - Infiltrative - eg, [sarcoidosis](#), [amyloidosis](#), [haemochromatosis](#), [Löffler's eosinophilia](#), connective tissue disease.
  - Infective - eg, Chagas' disease, [HIV](#).
- Arrhythmias - tachyarrhythmias or bradyarrhythmias.

- Conditions where there is increased peripheral demand on the heart – this occurs when cardiac output is normal or increased in the face of much increased needs. It can occur with a normal heart but even earlier if there is heart disease. This can be termed high-output cardiac failure. Causes include:
  - Anaemia.
  - Pregnancy.
  - Sepsis.
  - Hyperthyroidism.
  - Paget's disease of bone.
  - Arteriovenous malformations.
  - Beriberi.

## Presentation<sup>[4]</sup>

In general, the heart fails as a whole. However, sometimes a disproportionate burden falls on one ventricle and this influences the pattern of symptoms and signs. There is no symptom or sign that is both sensitive and specific for chronic heart failure.<sup>[5]</sup>

### Symptoms of heart failure

Patients do not necessarily have all and some may be predominant at times. In addition, patients may be depressed or complain of drug-related side-effects.

- Dyspnoea on exertion and fatigue (may limit exercise tolerance).
- Orthopnoea (breathlessness on lying flat).
- Paroxysmal nocturnal dyspnoea (PND).
- Fluid retention (may cause pulmonary or peripheral oedema. If the latter, the patient may complain of weight gain, ankle swelling, or a bloating sensation).
- Nocturnal cough ( $\pm$  pink frothy sputum) or wheeze.

- Light-headedness or syncope.
  - Anorexia.
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## Signs of heart failure

- There may be a tachycardia at rest, low systolic blood pressure (BP), a displaced apex (LV dilatation) or RV heave (pulmonary hypertension), a narrow pulse pressure or pulsus alternans (alternating large and small pulse pressures) and a raised JVP.
- There may be a gallop rhythm due to presence of S3 (see also the separate [Heart Auscultation](#) article) or murmurs of mitral or aortic valve disease.
- Bilateral basal end-inspiratory crackles ± wheeze ('cardiac asthma').
- Tachypnoea.
- Pleural effusions.
- Tender hepatomegaly – pulsatile in tricuspid regurgitation, with ascites.
- Often extensive peripheral oedema. There may be swollen ankles, sacral oedema or ascites.
- In acute failure the patient may look ill and exhausted and there may be cyanosis.

The peak expiratory flow rate may be reduced but, if it is <150 litres/minute, suspect chronic obstructive pulmonary disease (COPD) or asthma.

## Investigations<sup>[3]</sup>

Having taken a history and performed an examination then the following investigations are recommended by NICE.

### Measure NT-proBNP

A blood test to check [N-terminal pro-B-type natriuretic peptide \(NT-proBNP\)](#) should be done in all people with heart failure. Previous NICE guidance distinguished between management of those with a prior history of MI and those without, but updated 2018 guidelines recommend that:

- All those with suspected heart failure and an NT-proBNP level  $>2,000$  ng/L (236 pmol/L) be referred urgently, to have specialist assessment and transthoracic echocardiography within two weeks. (This is equivalent to B-type natriuretic peptide (BNP level)  $>400$  pg/mL (116 pmol/L) where NT-proBNP is not available.)
- All those with suspected heart failure and an NT-proBNP level between 400 and 2,000 ng/L (47 to 236 pmol/L) are referred to have specialist assessment and transthoracic echocardiography within six weeks. (This is equivalent to a BNP level between 100-400 pg/mL (29-116 pmol/L) where NT-proBNP is not available.)
- If the levels are normal (NT-proBNP level  $<400$  ng/L or BNP  $\leq 100$  pg/ml), heart failure is unlikely and other diagnoses should be considered. If there is still clinical suspicion of heart failure, discuss with a specialist physician.

Note that BNP levels can be elevated in other situations than heart failure – for example:

- Left ventricular hypertrophy.
- Ischaemia.
- Tachycardia.
- Hypoxaemia.
- Renal dysfunction (eGFR  $<60$ ).
- Age over 70.
- Liver cirrhosis.
- Sepsis.
- COPD.
- Diabetes.

Note that BNP levels can be reduced in certain circumstances such as:

- Obesity.
- African-Caribbean origin.

- Medication – diuretics, ACE inhibitors, angiotensin-II receptor blockers, beta-blockers, mineralocorticoid receptor antagonists.

## **ECG**

Arrange an [ECG](#) in all patients with suspected heart failure. This not only identifies potential aetiological factors (for example, myocardial infarction or arrhythmias) but is also necessary for treatment decisions – eg, rate control and anticoagulation for AF or pacing for bradycardia. A normal ECG makes heart failure very unlikely (sensitivity 89%).<sup>[1]</sup>

## **Echocardiography**

Following referral, all patients should have transthoracic [echocardiography](#) performed within the timescale above. This identifies valve disease and ventricular dysfunction, and detects shunts.

In people presenting with new suspected acute heart failure, consider performing transthoracic echocardiography within 48 hours of admission to guide early specialist management.<sup>[2]</sup>

## **Other tests**

Consider further tests to exclude other diagnoses and to ascertain aetiology, including:

- Blood tests: FBC, U&E and eGFR, LFTs, HbA1c, lipids, TFTs; consider cardiac enzymes if an undiagnosed MI is possible in the preceding few days.



- CXR – provides supportive evidence for heart failure and helps to exclude other potential causes of breathlessness. Typical findings in heart failure include:
  - Cardiomegaly (cardiothoracic ratio >50%).
  - Ventricular hypertrophy.
  - Prominent upper lobe veins (upper lobe diversion).
  - Peribronchial cuffing.
  - Diffuse interstitial or alveolar shadowing – classical perihilar 'bat's wings' or nodular (especially with pre-existing COPD).
  - Fluid in the fissures.
  - Pleural effusions.
  - Kerley B lines.

Apart from pulmonary congestion, CXR findings are only predictive of heart failure where there are co-existing typical signs and symptoms.

- Urinalysis.
- Lung function tests ([peak flow](#) or [spirometry](#)).
- [Cardiac magnetic resonance imaging](#) – the gold standard for assessing ventricular volumes, mass and wall motion. It can be used with contrast to identify inflammation, infiltration and scarring of the myocardium. MRI or radionuclide imaging may be useful where there was poor imaging on echocardiography.

## Staging

The New York Heart Association's (NYHA) Classification of Heart Failure has provided a clinically useful, functional classification, outlined below: <sup>[6]</sup>

- Class I: no symptoms on ordinary physical activity.
- Class II: slight limitation of physical activity by symptoms.

- Class III: less than ordinary activity leads to symptoms.
- Class IV: inability to carry out any activity without symptoms.

## Indications for specialist referral<sup>[3]</sup> <sup>[4]</sup>

All those with suspected heart failure should be referred to a specialist cardiac failure multidisciplinary team. Refer for immediate assessment all those with severe symptoms or pregnant women with suspected heart failure.

Adults with suspected heart failure should have specialist assessment and transthoracic echocardiography within two weeks of referral if they have a very high N-terminal pro-B-type natriuretic peptide (NT-proBNP) level (over 2,000 ng/L), or six weeks if they have a high NT-proBNP level (between 400 and 2,000 ng/L).<sup>[7]</sup>

## Prognosis of heart failure<sup>[4]</sup>

- Prognosis is poor on the whole, with approximately 50% of people with heart failure dying within five years of diagnosis.
- The mortality rate in the UK appears to be improving. The UK National Heart failure audit found the mortality of patients hospitalised with heart failure to be 9% in 2020–21.
- The prognosis for people with heart failure and preserved LV ejection fraction is a little better than the prognosis for people with heart failure and reduced ejection fraction. Generally, the lower the ejection fraction, the poorer the prognosis.
- Other poor prognostic factors (although this does depend on the type of heart failure) include:<sup>[8]</sup>
  - Increasing age.
  - Smoking.
  - Diabetes and other comorbidities (such as atrial fibrillation, chronic kidney disease, COPD).
  - Obesity or low BMI.

**Management** of heart failure is discussed in the separate [Heart Failure Management](#) article.

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## Further reading

- [Acute heart failure: diagnosis and management in adults](#); NICE Quality Standard, December 2015
- [Roberts E, Ludman AJ, Dworzynski K, et al](#); The diagnostic accuracy of the natriuretic peptides in heart failure: systematic review and diagnostic meta-analysis in the acute care setting. *BMJ*. 2015 Mar 4;350:h910. doi: 10.1136/bmj.h910.
- [Real J, Cowles E, Wierzbicki AS](#); Chronic heart failure in adults: summary of updated NICE guidance. *BMJ*. 2018 Sep 24;362:k3646. doi: 10.1136/bmj.k3646.

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