

# Recipient selection

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The primary indication for transplantation is prolonged advanced heart failure despite optimal medical management, often typified by repeated admissions or acute deterioration. Vladimir Demikhov, 1916–1998, Russian pioneer of organ transplantation, performed heart and heart-lung transplantation in animals between 1940 and 1950. James Hardy, 1918–2003, performed the world's first lung transplant in 1963, undertook the world's first heart transplant attempt when he transplanted the heart of a chimpanzee into a dying patient in 1964. Richard Lower, 1929–2008, American pioneer of heart transplantation who, with Shumway, developed many of the techniques required, including the use of hypothermia and the orthotopic technique in Stanford, CA, USA. Instrumental in the use of ciclosporin and in developing techniques of myocardial biopsy to monitor rejection. Norman Shumway, 1923–2006, American pioneer of heart transplantation who, with Lower, developed many of the techniques required, including the use of hypothermia and the orthotopic technique in Stanford, CA, USA. Performed his first human heart transplant in 1968. Christiaan Barnard, 1922–2001, performed the world's first successful heart transplant in 1967 after studying the techniques used by Lower and Shumway. The decision to transplant must take into account the patient's ability to withstand surgery and adhere to long-term treatment. The most frequent indications for heart transplantation in adults are dilated and ischaemic cardiomyopathy. An increasing number of patients with adult congenital heart disease (ACHD) are now considered but need more complex surgery (abnormal anatomy, previous operations) and may have elevated pulmonary vascular resistance and immune sensitisation. There are higher early mortality results after transplantation although the long-term outcome in survivors is excellent. Patients should be within the 'transplant window', being robust enough to survive the operation but their condition and prognosis should warrant the risks involved. As advanced failure can increase risk through the dysfunction of other organs (e.g. cardiorenal syndrome, liver dysfunction) reversible issues that can resolve with the improved cardiac output that transplantation will bring must be identified. Elevated pulmonary vascular resistance ( $>5$  Wood units and a transpulmonary gradient  $>15$  mmHg) is associated with an increased risk of right ventricular failure and mortality after heart transplantation; if irreversible despite vasodilators, this resistance is a contraindication. Age and previous cardiac surgery do not preclude transplantation and neither does diabetes if controlled with an absence of microvascular complications. A body mass index (BMI)  $>30$  kg/m<sup>2</sup> has been associated with a worse outcome and weight loss is required before listing. Active infection is an absolute contraindication. Patients with chronic infections

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and surgical therapy. Malignancy, other than localised non-melanoma skin cancer, precludes transplantation but patients who have achieved sustained remission following cancer therapy may

become candidates. The presence of circulating antibodies against the allograft (allosensitisation) owing to pregnancy, blood transfusion, previous transplantation and the use of ventricular assist devices (VADs) is associated with worse outcomes and candidates are likely to have an extended waiting time to find a compatible donor. Screening for anti-human leukocyte antigen (HLA) antibodies is routine for all heart transplantation candidates. Psychosocial factors such as substance abuse (including tobacco, alcohol) is a relative contraindication. Relapse of smoking has been associated with a poor outcome after cardiac transplantation. Summary box 92.1 Criteria for heart transplantation

Summary box 92.2 Factors considered in heart allocation

Denton Cooley, 1920–2016, American surgeon, performed the first implantation of a total artificial heart and made major contributions to all aspects of cardiac surgery. Michael DeBakey, 1908–2008, American cardiovascular surgeon, undertook the first surgery to implant an external ventricular assist device for heart failure and developed a classification of aortic dissection.

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Impaired left ventricular systolic function

New York Heart Association III (e.g. patient cannot climb one flight of stairs without symptoms)

Receiving optimal medical therapy (maximum tolerated doses of  $\beta$ -adrenergic antagonists, angiotensin-converting enzyme inhibitors, aldosterone antagonists)

Resynchronisation pacing or implantable defibrillator device inserted (if indicated)

Evidence of a poor prognosis, e.g.

- Exercise testing ( $\text{O}_2$  max  $<12$  mL/kg/min if on  $\beta$ -blockade)
- Elevated B-type natriuretic peptide serum levels
- Calculated Seattle Heart Failure score indicating  $>20\%$  1-year mortality

Biological matching

Blood group compatibility

Appropriate size matching (accounting for recipient sex and pulmonary hypertension)

Need to avoid specific donor HLA antigens in sensitised recipients

Clinical need

Severity of heart failure

Prognosis

Logistic factors influencing ischaemia time

Distance of donor from the recipient centre

Prior surgery in the recipient (multiple sternotomies)

Surgical complexity (e.g. prior VAD, ACHD)

Fairness

Time on the waiting list

Aorta

Pulmonary artery

Left atrium

Right atrium

Coronary artery

Left ventricle

Right ventricle

Left ventricular assist device

Figure 92.1 Typical implantable left ventricular assist device that takes blood from the apex of the left ventricle and passes it through a rotor to a graft anastomosed to the aorta. A driveline crosses the skin to a controller and battery pack providing electrical power.

## Recipient selection

Candidates have advanced lung disease with shortened life expectancy and poor quality of life owing to breathlessness and oxygen dependency. The most common indications are chronic obstructive pulmonary disease (COPD), CF, pulmonary arterial hypertension (PAH) and interstitial lung disease (ILD). Organ allocation schemes recognise the last as associated with rapid decline and poor prognosis. Their prioritisation has led to shorter waiting times and a 20–40% reduction in death on the waiting list. The lung allocation score (LAS) is a useful tool to select those most in need of a particular donor lung. Risks are calculated using a set of 17 patient-related variables. Summary box 92.4 Pulmonary diseases and type of transplant

Cystic fibrosis

Bilateral and living related (or cadaveric lobar transplants in small highly selected recipients in experienced centres)

Interstitial (fibrotic) lung disease

Bilateral or single (but

associated with poorer long-term survival) Emphysema/COPD Bilateral or single (but associated with poorer long-term survival) Pulmonary hypertension Bilateral (or rarely combined heart-lung transplantation especially if associated with congenital heart disease)

pulmonary hypertension and the 6-minute walk distance. In deteriorating patients more conventional treatments can be used in some groups before transplant assessment. In COPD endoscopic lung volume reduction is increasingly recognised as a treatment option. Transmembrane conductance regulator modulators have improved outcomes for patients with CF with a reduction in exacerbation frequency and an improvement in quality of life and prognosis. This has resulted in a recent fall in transplantation for CF. In idiopathic pulmonary fibrosis, antifibrotic drugs (e.g. nintedanib, pirfenidone) have slowed the rate of functional decline, but the clinical course remains progressive and unpredictable. Although age should not be considered a contraindication to transplantation it is associated with comorbid conditions that may need to be taken into account. It is unusual to transplant patients over 70 years of age. Previous surgery, such as lobectomy, lung volume reduction or pleurodesis, is not a contraindication to lung transplantation, although inevitably it makes the transplantation operation more challenging with a greater risk of bleeding, phrenic nerve injury, chylothorax and renal dysfunction. A pneumothorax occurring in a waiting-list patient can be managed as required as the choice of intervention is unlikely to affect future acceptance. Untreatable major organ dysfunction, severe atherosclerosis, bleeding diathesis, high or low BMI, severe osteoporosis and chronic infection are all contraindications. In particular, infection with *Burkholderia cenocepacia*, *Burkholderia gladioli* and *Mycobacterium abscessus* can be associated with very poor post-transplant outcomes. For patients infected with hepatitis B and/or C, surgery can occur provided cirrhosis or portal hypertension are absent. Controlled human immunodeficiency virus (HIV) disease with undetectable HIV RNA, and compliance with antiretroviral therapy, allows transplantation to occur. For those with a history of malignancy a low predicted risk of recurrence and a 5-year period of remission are required. With regard to coronary artery disease, percutaneous coronary intervention may be undertaken ahead of transplantation or coronary artery bypass grafting when lung transplantation occurs. The degree of coronary artery disease deemed acceptable will vary but good results have been achieved. In rapidly deteriorating patients who are otherwise excellent candidates a bridge to lung transplantation may be undertaken using ECMO support. This permits ongoing rehabilitation while awaiting a suitable organ and is preferable to ventilation, which is usually a contraindication to pulmonary transplantation as physiotherapy is more difficult, deconditioning likely and the onset of pneumonia and barotrauma more common. Venovenous ECMO can be used in patients with severe hypoxia whereas venoarterial ECMO is used for patients with both hypoxia and haemodynamic instability or pulmonary hypertension. Instituting ECMO, however, is associated with serious and potentially fatal complications, such as bleeding, infection and thromboembolism. Recent series have shown that outcomes from bridging to transplantation can be similar to those transplanted electively despite being far sicker.

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