

lung transplant

patient selection

indications

LUNG TRANSPLANT BY PROCEDURE TYPE (IN ORDER OF FREQUENCY)

Single Lung Transplant	Double Lung Transplant
Emphysema/COPD	Cystic fibrosis
Idiopathic pulmonary fibrosis	Emphysema/COPD
Alpha ₁ -antitrypsin deficiency	Alpha ₁ -antitrypsin deficiency
Re-transplant	Idiopathic pulmonary fibrosis
	Primary pulmonary hypertension
	Bronchiectasis

contraindications

- Contraindications to transplant include:
 - evidence of extrapulmonary disease such as significant kidney, liver, or cardiac disease
 - poor nutritional or rehabilitation status;
 - recent or current malignancy; and
 - a poor psychosocial profile.

donor criteria

STANDARD LUNG TRANSPLANT DONOR CRITERIA

Age < 55 yr
ABO blood group compatibility
Clear chest radiograph
P _a O ₂ > 300 mm Hg on fractional inspired oxygen of 1.0 and positive end-expiratory pressure = 5 cm H ₂ O
Less than 20 pack-year smoking history
Absence of chest trauma
No aspiration or sepsis
Gram stain shows sputum sample free of bacteria, fungus, and significant number of white blood cells

early post-operative complications

hypotension

- the immediate hemodynamic goal in the lung transplant recipient is intravascular volume depletion. Although achieving the goal of reducing the tendency toward pulmonary edema, this strategy often results in hypotension.
- If hypotension occurs, gentle volume resuscitation with colloids such as albumin or red blood cell transfusion can reestablish an adequate blood pressure, while not contributing significantly to pulmonary edema development.
- If the recipient experiences problems with positive-pressure-related hypotension, removal from the mechanical ventilator is the treatment of choice.

ventilatory instability

- (i) mucous plugging
 - Plugging of the airways, either with retained mucus or blood, is very common and can cause rapid ventilatory insufficiency. The development of this problem is suggested by acute increases in ventilatory pressure but is definitively diagnosed by bronchoscopic examination of the airways.
 - Treatment involves the removal of mucus or blood blocking the airway.
- (ii) allograft problems:
 - Problems with early allograft function also lead to inadequate ventilation and oxygenation.
 - These problems are usually temporary and are best managed simply through supportive measures.
 - However, in the case of primary graft failure, the oxygenation and ventilatory problems are more profound and require more complex management strategies.
 - In the setting of a double-lung transplant, the management should include the application of increased levels of PEEP and, if necessary, alterations of inspiratory to expiratory ratios.
 - In single-lung recipients, one can selectively ventilate the native lung while other measures are taken to improve allograft performance. This strategy can be accomplished through the use of double-lumen endotracheal tubes, which allow independent lung ventilation.
 - In cases of important allograft dysfunction, positioning the patient on the side with the native lung "down" can lead to increased perfusion to that side (i.e., the side with less pulmonary edema) and can lead to improvements in oxygenation

bleeding

- Postoperative bleeding issues are similar to other thoracic surgical patients and are best handled by correction of coagulopathies and replacement of red blood cells. As in other thoracic patients, careful chest tube output monitoring is essential in detecting and, ultimately, treating excessive bleeding.
- Return to the operating room for exploration in the presence of excessive bleeding is not uncommon after lung transplantation.
- Bleeding complications are generally more common in patients in whom dissection to free the native lung is difficult, such as in cystic fibrosis patients or in patients with fibrotic lung diseases.

bronchial anastomosis problems

- Complications with the bronchial anastomosis, such as dehiscence or stricture, usually occur later in the postoperative period.

pulmonary artery anastomosis problems

- Pulmonary artery stricture, or narrowing, is fortunately very uncommon. When it does occur, problems with oxygenation are seen and usually occur in the absence of radiographic abnormalities. The diagnosis is initially one of exclusion, where more common causes of poor oxygenation are investigated first.
- Diagnosis requires pulmonary angiogram

pulmonary venous anastomosis problems

- Because of the technical challenges associated with it and the low-flow state of the venous system, the venous anastomosis is susceptible to kinking or clot formation.
- Both of these complications cause impedance of venous return and back flow of blood into the pulmonary vasculature. This results in immediate and profound pulmonary edema that is refractory to all supportive measures.
- A clinical scenario of this kind should prompt immediate investigation, ideally via visualization and Doppler measurement of the venous anastomosis using transesophageal echocardiography.

post operative care

haemodynamic management

- In the early postoperative period, proper fluid management may be the most important aspect of lung transplant care.
- the transplanted lung has a propensity toward pulmonary edema because:
 - the lymphatic drainage is disrupted during surgery,
 - lung allografts suffer a lung injury that is characterized by a diffuse capillary leak (known as the reimplantation response)
 - intraoperative and early postoperative hypotension occurs commonly & overexuberant resuscitation with crystalloid solutions sometimes occurs
- Especially in the first 72 hours after surgery, judicious use of intravenous fluids should be exercised and efforts should be made to minimize fluid administration while maintaining adequate urine output.

ventilator management

- During periods where hypotension is found to be the result of profound intravascular volume depletion, fluid resuscitation should ideally include solutions that have the greatest tendency to remain in the vascular space and not simply migrate through the dilated pulmonary capillary channels.
- Ventilatory modes:
 - In most patients SIMV with rapid movement towards CPAP + PS and early extubation is most appropriate
 - In patients with poor early graft function, for example those with primary graft failure, ventilatory strategies that limit barotrauma are most efficacious and usually include pressure-control modalities.
- The Use of Positive End-Expiratory Pressure
 - Positive end-expiratory pressure (PEEP) can be safely used in lung transplant recipients, especially those patients who have received a bilateral lung transplant.
 - In the double-lung recipients, the compliance characteristics of the two allografts will be similar; therefore, the positive pressure exerted on each lung will be nearly evenly distributed.
 - PEEP of +5 to +15 is safe in this patient population. In fact, some believe that PEEP has a beneficial effect in this group in decreasing postoperative bleeding by increasing intrathoracic pressure, which would lead to tamponade of the small blood vessels in the chest.
 - In single-lung recipients, the use of PEEP can be more problematic. The differing compliance characteristics of the remaining native lung and the allograft lead to the potential for a majority of the positive pressure being directed at only one lung which leads to a situation known as acute native lung hyperinflation.
 - The hyperinflated native lung can cause both cardiac tamponade, manifested as acute hypotension associated with a reduction in cardiac index, and allograft compression, manifested by hypoxemia and hypercarbia. Because of these potential problems, the avoidance of high levels of PEEP in patients with emphysema undergoing single-lung transplantation is generally recommended.

chest physio & patient positioning

- Chest physiotherapy is an essential part of postoperative respiratory management. Because the allograft is denervated, the cough reflex in lung transplant recipients is impaired.
- Patient positioning in the bed can help minimize the development of pulmonary edema. Regardless of the initial condition of the transplanted lung, the allograft side should be placed upward for the first 6 hours postoperatively while the patient is in the lateral decubitus position to diminish its blood flow and ideally its tendency to develop pulmonary edema.

immunosuppression

- Some programs use an induction strategy that involves the early administration of antibody, either directed directly at the lymphocyte ("lymphocyte-depleting") or against interleukin receptor sites. Regardless of which induction agent is preferred, a primary advantage of this strategy involves the early avoidance of nephrotoxic immunosuppressive while still providing adequate immunosuppression.
- Most lung transplant programs use a three-drug immunosuppressive regimen.
- Corticosteroids are a central part of the early strategy, particularly during the period when adequate blood levels of the other immunosuppressive agents are not yet achieved.
- Calcineurin inhibitors such as tacrolimus and cyclosporine-based medications comprise the second part of the three-drug strategy.
- The third part of the immunosuppressive regimen involves the use of either azathioprine or mycophenolate mofetil.

infectious disease prophylaxis

- Infections after lung transplant are common and occur because of baseline immunosuppression, transmission from the donor, and ICU-related instrumentation (e.g., chest tubes, central venous catheters, endotracheal tubes).
- The antibiotic prophylactic regimen is directed toward preventing pneumonia, surgical site infections, and central line-related infections. Usually, this goal is achieved through the prophylactic use of late-generation cephalosporins and vancomycin.
- To prevent both the acute and chronic consequences of CMV infection, many programs have adopted an aggressive CMV prophylactic protocol.
- The prophylactic use of antifungal agents is controversial and varies among centers.

prognosis

- Long-term survival after lung transplantation is limited by the development of the bronchiolitis obliterans syndrome (BOS), which is commonly referred to as chronic rejection.
- BOS, defined by declining spirometry below the best postoperative level achieved, is variable in time to onset but increases in frequency as duration post transplant lengthens