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EDITOR'S NOTE

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Nutritional deficiencies are common occurrence in advance heart and lung failure patients. These deficiencies are aggravated while these patients undergo transplant surgery and can adversely affect the transplant outcomes and delay wound healing.

The importance of using screening tools and ensuring adequate nutrition begins in the pre-transplant phase and continues from there-on for the entire lifetime of our patients.

This article encompasses all aspects of nutrition considerations for out heart and lung transplant patients. The clear flowcharts and detailed yet clear tables further makes this an enjoyable read. Take particular note of the practical dietary tips and importance of functional food supplementation for our post-transplant patients.

Warm regards,
Dr. Talha Meeran

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Special thanks to Dr. Eileen Canday and Trinette Dsouza for authoring this month's article.

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SUB EDITOR'S NOTE

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Nutrition remains one of the most under-appreciated determinants of outcomes in heart and lung transplantation. While advances in surgical techniques and immunosuppression have transformed survival, the burden of malnutrition, sarcopenia, and metabolic complications continues to significantly influence recovery and long-term success.

In this issue of Revival, the authors present a concise and clinically relevant overview of nutritional management across the transplant continuum—from pre-transplant optimization to post-transplant metabolic care. The article highlights the importance of early nutritional screening, structured assessment, and individualized interventions as integral components of transplant care.

What stands out is the practical emphasis on multidisciplinary collaboration and the recognition that nutrition is not merely supportive, but therapeutic. The discussion on functional foods and drug–nutrient interactions further underscores the evolving scope of nutritional science in transplant medicine.

As heart failure and transplant programs expand across India, integrating nutrition into routine clinical pathways will be essential to improving patient outcomes. This piece serves as both a valuable guide and a timely reminder to place nutrition at the center of comprehensive transplant care.

Warm regards,
Dr. Aditi Singhvi

NUTRITION MANAGEMENT IN HEART AND LUNG TRANSPLANT PATIENTS

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Heart and lung transplant are lifesaving interventions for those suffering from end-stage heart failure and lung diseases. These patients are at increased risk of presenting with severe metabolic abnormalities and poor nutritional status. Malnutrition, sarcopenia, and micronutrient deficiencies are common among these patients and might be one of the causes of increased morbidity and mortality. [1,9,23]

Nutrition therapy is of vital importance at every stage of the transplant process, including pre-transplant, peri-transplant, and long-term post-transplant periods. It is of great importance to conduct nutritional screening and implement individualized nutrition interventions as a member of the team to ensure better outcomes. [6,7,30]

Importance of Timely Nutrition Assessment and Intervention in Heart & Lung Transplant [6,7,30]

Nutritional screening and intervention are an integral part of the management for patients awaiting heart and lung transplantation. Patients with end-stage heart failure and lung diseases have various manifestations of protein-energy malnutrition, sarcopenia, and micronutrient deficiencies, as well as various metabolic complications, due to chronic inflammatory states, decreased oral intake, high energy expenditure, and drug regimens. [1,9,23]

Nutritional deficiencies have been related to an increase in infections, wound healing complications, mechanical ventilation time, and intensive care unit stay among transplant patients. Nutritional deficiencies have been known to compromise the strength of respiratory muscles, the immune system, and rehabilitation, which can have implications for graft survival and outcome. [6,7,30]

Nutrition assessment at appropriate times can help identify patients at higher risk and provide appropriate interventions, including dietary counselling, oral nutritional supplements, early enteral nutrition, and parenteral nutrition if necessary. Pre-transplant optimization of nutritional status has been demonstrated to improve functional status, reduce perioperative complications, and improve the outcome in the postoperative phase. [6,7,30]

Moreover, monitoring of nutritional status before and after transplantation is critical because immunosuppressive agents can cause various metabolic complications, including hyperglycemia, dyslipidemia, hypertension, and weight gain. [6,7,30]. Frailty and reduced functional reserve are also recognized predictors of mortality following lung transplantation [17].

The International Society for Heart and Lung Transplantation (ISHLT) recommends that patients being considered for heart and lung transplantation should be evaluated and managed by a multidisciplinary team of healthcare professionals, including those involved in nutritional and metabolic support. The guidelines focus on the importance of nutritional factors such as body mass index, glucose metabolism, weight loss, and frailty indicators as part of the transplant evaluation process, highlighting the role of dietitians. [4,18,19]

Pathophysiology and prevalence of Malnutrition in Transplant patients [1,9,23]

Nutritional intake is very commonly decreased in patients with heart failure and chronic lung diseases, and this can be due to various symptoms like anorexia, fatigue, nausea, dyspnea, and early satiety, etc. In patients with heart failure, decreased nutrient intake can be due to gastrointestinal congestion, intestinal edema, and decreased perfusion of the splanchnic organs, which can lead to decreased nutrient intake. Studies have shown that 46% of patients with heart failure are malnourished, which shows the effect of heart failure on the nutritional status of patients with this condition. Symptoms like fatigue, early satiety, and nausea can lead to decreased caloric intake and weight loss in patients with heart failure.

In addition to malnutrition, sarcopenia, which is the progressive loss of skeletal muscle mass and function, is also very common in patients with heart failure. Meta-analyses have shown that the overall prevalence of sarcopenia in patients with heart failure is about 31-34%, ranging from 10% to 69% depending on the criteria used [3]. Sarcopenia is more prevalent in hospitalized patients and is linked to decreased physical function, higher rates of hospitalization, and adverse outcomes.

Likewise, patients with chronic respiratory diseases like chronic obstructive pulmonary disease (COPD) are also at a high risk of malnutrition and muscle wasting. Difficulty in breathing during meals, fatigue, and the high work of breathing may decrease food intake while simultaneously increasing energy expenditure. It has been reported in studies that protein-energy malnutrition is present in about 25-40% of patients with COPD, and global analyses have revealed that nearly 30% of patients with COPD are malnourished or at risk of malnutrition [4,5]. Patients with COPD are also at a high risk of sarcopenia due to systemic inflammation, physical inactivity, and high energy expenditure due to chronic respiratory insufficiency. The presence of malnutrition and sarcopenia further worsens the functional status, exercise tolerance, and quality of life in patients with cardiopulmonary diseases.

Nutritional Assessment in Transplant Patients [6,7,30]

A nutritional assessment is performed during the pre-transplant period, ideally in the early phase, and is often repeated during the pre- and post-transplant periods. Nutritional status, sarcopenia, and frailty are established predictors of outcome in transplant patients. Thus, nutritional assessment in transplant patients is recommended to address malnutrition and nutritional status. Malnutrition is associated with complications, prolonged hospital stay, and mortality in transplant patients. [1,9,23]

Key Components of Assessment

1. Anthropometry

Anthropometric measures are simple and commonly used measures of nutritional status in transplant candidates. [6,7,30]

- **Body Mass Index (BMI):**
  The use of BMI as an indicator of underweight, normal weight, overweight, and obesity has been common. Severe obesity and low BMI are associated with increased perioperative risk and poor outcomes.
- **Body Composition:**
  The use of methods such as Bioelectrical Impedance Analysis (BIA), Dual-Energy X-Ray Absorptiometry (DEXA), and Computed Tomography (CT) to measure body composition has been used to identify sarcopenia and muscle depletion. Sarcopenia is common among transplant candidates and has been associated with poor outcomes. The pooled prevalence of sarcopenia was found to be 40 percent in a meta-analysis of solid organ transplant candidates.

2. Biochemical Parameters

These are important in assessing nutritional and inflammatory status.

- **Serum Albumin [26]:**

Serum albumin is commonly used for assessing disease severity and prognosis in transplant patients. Low serum albumin is associated with increased morbidity, complications, and mortality. However, serum albumin is also influenced by inflammation, hydration status, and liver function. Thus, this parameter must always be interpreted in relation to other patient symptoms.

- **Prealbumin (Transthyretin) [26,29]:**

Transthyretin, or prealbumin, is a sensitive marker for short-term protein status and has been used as a prognostic marker for patients with end-stage heart and lung disease awaiting transplantation. Low levels of transthyretin have been related to malnutrition, systemic inflammation, and clinical outcomes such as increased postoperative complications and mortality, emphasizing the utility of transthyretin as a marker for nutritional status in transplant candidates. [1,9,23,26,29]

- **C-Reactive Protein (CRP) [10]:**

This is an important parameter for interpreting nutritional markers since inflammation results in decreased hepatic protein synthesis, causing decreased albumin and prealbumin levels. [26,29]

- **Renal and Liver Function Tests:**

These tests are important in assessing organ functions and individualized dietary modifications in transplant candidates.

- **Lipid Profile:**

This is important since lipid abnormalities are commonly seen in transplant patients due to immunosuppressive drugs. These abnormalities increase the risk for cardiovascular disease.

Heart Transplant Nutrition Considerations [6,7,30]

Cardiac cachexia, characterized by substantial loss of body mass, can be seen among patients having advanced heart failure. This is an established complication of chronic heart failure, with high mortality risk [35].

Nutritional goals:

- Prevention of progressive muscle loss
- Sodium and fluid balance
- Correction of micronutrient deficiencies
- Improvement of functional status prior to transplant

Metabolic complications like post-transplant diabetes, dyslipidemia, and hypertension are common after heart transplant, and dietary management of these complications is essential.

Lung Transplant Nutrition Considerations [6,7,30]

Patients with end-stage lung disease are at risk of hypermetabolic states due to increased work of breathing.

Nutritional goals:

- **High-caloric intake to meet increased energy demand**
- **Adequate protein intake to maintain muscle mass**
- **Anti-inflammatory nutrient supplementation** - which can be of potential benefit to lung transplant patients, include omega-3 polyunsaturated fatty acids, antioxidant vitamins like vitamin E and vitamin C, carotenoids, polyphenols, and selenium, which can reduce inflammation, oxidative stress, and immune-mediated tissue damage.

Fat-soluble vitamins include vitamins A, D, E, and K, and deficiencies in these vitamins are common among cystic fibrosis patients due to pancreatic insufficiency, which affects the absorption of fats. Routine monitoring for deficiencies in

these vitamins is important in the management of cystic fibrosis to prevent complications such as night blindness, bone disease, coagulopathy, and neuromuscular disease.

Table 1. Nutritional Screening Tools Used in Transplant Candidates [6,7,30]

Screening Tool / Assessment	Key Components	Clinical Utility / Setting
Subjective Global Assessment (SGA)	Weight loss, dietary intake, gastrointestinal symptoms, physical exam	Widely used to diagnose malnutrition; suitable for outpatient or clinic-based transplant evaluation
Nutrition Risk Screening (NRS-2002)	Weight loss, reduced intake, disease severity	Identifies hospitalized patients at nutritional risk; recommended as tool of choice for inpatients
Nutritional Risk Index (NRI)	Serum albumin and weight ratio	Predicts postoperative complications; can support perioperative nutritional assessment
Mini Nutritional Assessment (MNA)	Dietary intake, BMI, functional status	Useful in elderly transplant candidates or those with frailty
GLIM Criteria	Phenotypic criteria (weight loss, low BMI, reduced muscle mass) and etiologic criteria (reduced intake/ assimilation, inflammation)	Global standard for diagnosing malnutrition; applied after initial screening to confirm and grade malnutrition

Nutritional screening tools are essential in identifying patients at risk and improving clinical outcomes when early nutritional support is provided [10,16]. In transplant candidates, NRS-2002 is advocated as the first-line method for screening hospitalized patients, while SGA or MUST can be used in the outpatient or clinic setting; once a patient is identified as having nutritional risk, the GLIM criteria can be used to standardize the diagnosis and staging of malnutrition. [1,9,23,13,8]

Nutritional Screening and Diagnosis in Transplant Candidates [6,7,30]

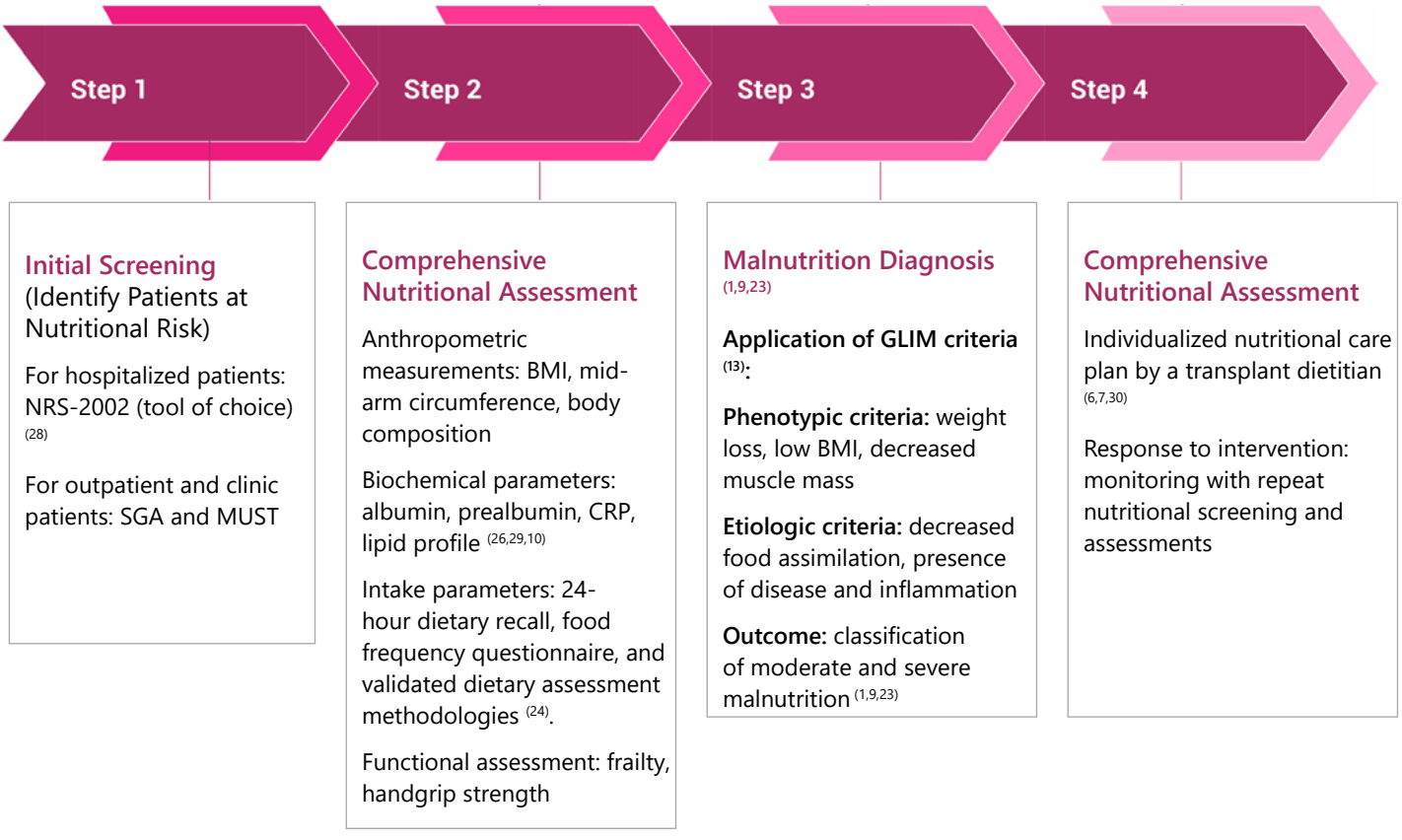

Table 2. Recommended Macronutrient Requirements in Transplant Patients [7,11,16,30]

Clinical Phase	Energy Requirement	Protein Requirement	Clinical Goal
Pre-transplant	25–30 kcal/kg/day	1.2–1.5 g/kg/day	Prevent muscle wasting
Severe malnutrition	35–40 kcal/kg/day	1.5–2.0 g/kg/day	Nutritional repletion
Early post-transplant	30–35 kcal/kg/day	1.3–1.8 g/kg/day	Promote wound healing
Critical illness	Individualized	Up to 2 g/kg/day	Support metabolic stress

Nutritional support during critical illness is associated with improved clinical outcomes and reduced complications [1,23].

Table 3. Important Micronutrients in Transplant Nutrition [6,7,30]

Micronutrient	Role	Clinical Importance
Vitamin D	Bone health, immune regulation	Prevents steroid-induced osteoporosis
Calcium	Bone mineralization	Required with corticosteroid therapy
Magnesium	Neuromuscular and cardiac function	Depletion common with diuretics
Folic acid	Homocysteine metabolism	Reduces cardiovascular risk
Omega-3 fatty acids	Anti-inflammatory effects	May support pulmonary function

Table 4. Drug–Nutrient Interactions in Transplant Patients [4,6,7,20]

Medication	Nutritional Effect	Dietary Consideration
Corticosteroids	Hyperglycemia, weight gain, bone loss	Control carbohydrate intake; provide calcium and vitamin D
Tacrolimus	Hyperglycemia, hyperkalemia	Monitor potassium and blood glucose
Cyclosporine	Hyperlipidemia	Heart-healthy low-fat diet
Diuretics	Electrolyte depletion	Monitor potassium and magnesium intake

Post-Transplant Nutritional Management [6,7,30]

After the transplant, patients can also suffer from metabolic problems, which can be caused by the immunosuppressive drugs. Corticosteroids and calcineurin inhibitors can cause hyperglycemia, dyslipidemia, hypertension, and weight gain. New onset diabetes after transplantation (NODAT) has been documented in a large number of patients.

Therefore, dietary approaches should focus on macronutrient balance, carbohydrate restriction with complex carbohydrates and fiber, and heart-healthy diets with essential fats that include both omega-3 and omega-6 fatty acids. Protein intake should be ensured in the diet of transplant patients, as it is essential for wound healing.

The safety of food is also an important issue to be considered in transplant patients, as immunosuppressive drugs can cause susceptibility to infections. Therefore, patients should practice strict hygiene, including food handling, avoiding raw food, and practicing neutropenic precautions.

Functional Foods in Heart and Lung Transplant Patients [31]

Functional foods are defined as foods that offer various health benefits to consumers in addition to their basic nutrient content, thanks to the presence of bioactive compounds like antioxidants, phytochemicals, probiotics, and omega-3 fatty

acids. For heart and lung transplant patients, functional foods can help alleviate oxidative stress, enhance the immune system, improve the metabolic profile, and improve cardiovascular health, which is critical in these patients because of the surgery and immunosuppression. Nutritional intervention and anti-inflammatory therapy are some strategies suggested for improving metabolism and inflammation among patients with heart failure [27].

Role of Functional Foods in Transplant Patients[31]

Transplant patients are prone to metabolic complications like dyslipidemia, hypertension, diabetes, and chronic inflammation after transplantation. Functional foods can be of great value in the management of these metabolic complications by:

- Managing oxidative stress and inflammation
- Supporting immune modulation
- Managing lipid and glucose metabolism
- Supporting gut health
- Supporting heart health

Table 5. Important Functional Foods for Heart and Lung Transplant Patients [31]

Functional Food	Bioactive Components	Potential Benefits	Food Sources
Omega-3 rich foods	EPA, DHA	Anti-inflammatory effects, improved lipid profile, cardiovascular protection	Fatty fish (salmon, sardines, mackerel), flaxseeds, chia seeds, walnuts
Antioxidant-rich fruits & vegetables	Vitamin C, polyphenols, carotenoids	Reduce oxidative stress, support immune function	Berries, citrus fruits, spinach, kale, carrots, tomatoes
Probiotic foods	Beneficial bacteria (Lactobacillus, Bifidobacterium)	Improve gut microbiota, enhance immune response	Yogurt (pasteurized)
Prebiotic foods	Dietary fiber, inulin	Promote healthy gut microbiota and digestive health	Oats, bananas, onions, garlic, asparagus
Turmeric	Curcumin	Anti-inflammatory and antioxidant effects	Curries, soups, turmeric milk
Ginger	Gingerols, shogaols	Anti-inflammatory, anti-nausea, digestive support	Ginger tea, fresh ginger used in cooked dishes
Nuts and seeds	Vitamin E, healthy fats	Cardioprotective, anti-inflammatory	Almonds, walnuts, sunflower seeds
Green tea	Catechins (EGCG)	Antioxidant and cardiometabolic benefits	Brewed green tea

Conclusion

Nutritional care has been considered to be of great importance in achieving optimal outcomes in heart and lung transplant patients. Early recognition of malnutrition and timely nutrition care can greatly impact the postoperative recovery of patients as well as their long-term survival. [1,9, 23]

The care of patients with heart or lung transplants requires a multidisciplinary approach from transplant physicians, dietitians, nurses, and rehabilitation specialists.

Practical Dietary Tips and Nutritional Considerations Post-Transplant [6,7,30]

1. Meeting Calorie Requirements

Heart and lung transplant patients have high energy demands during the recovery phase, which returns to normal over time. Meeting calorie requirements is essential for wound healing, immunity, and lean body mass preservation.

Tips to meet calorie requirements:

- Three meals a day, along with 2 to 3 snacks, must be included in the daily regimen to meet calorie requirements throughout the day.
- Oral Nutrition Supplements (ONS) can be taken between meals.

2. Adequate Protein Intake

Protein is an essential nutrient for immunity, healing, and the preservation of body mass, especially within the first 6 to 12 months following a transplant procedure.

High-quality protein sources:

- Animal protein sources: lean meats, fish, eggs
- Dairy sources: milk and milk products like paneer, curd
- Plant protein sources: dals and whole pulses, soya and tofu, rice protein & pea protein nutrition powder

Tip: Protein must be included in each meal and snack to meet the day's requirement.

3. Essential Fats

Essential fatty acids, particularly omega-3 and monounsaturated fats, can help manage and improve heart health, anti-inflammatory properties, and lipid profiles.

Sources of healthy fats:

- Omega-3 fatty acids: Fatty fish, flaxseeds, chia seeds, walnuts
- Monounsaturated fats: Olive oil, avocado, nuts

Tip: Try to replace saturated and trans fats with healthy fats.

4. General Meal Planning Tips

- Ensure that the majority of the meal consists of balanced food: Half plate of vegetables and fruits, one-fourth plate of protein, and one-fourth plate of grains.
- Add a rainbow of colourful fruits and vegetables to your daily meals.
- Frequent small meals may be given to the patient based on their appetite.
- Ensure that the patient drinks plenty of fluids, especially when on medications (unless restricted by the clinician)

5. Food Safety and Handling

Post-transplant patients are on immunosuppressive agents. They are at a higher risk of infections and foodborne diseases. It is therefore important to ensure that food is handled safely.

Guidelines:

- Ensure that hands are clean before handling food.
- Fruits and vegetables should be cleaned and washed well. All vegetables should be used only in cooked form. Fruits can be consumed either poached or stewed. Thick skinned fruits may be freshly cut and consumed immediately.
- Foods like meat, chicken, and fish should be cooked well. Raw or undercooked foods should not be eaten.
- Foods like unpasteurized dairy products, raw sprouts, deli meats that have not been cooked, and cheeses like Brie or Feta made from unpasteurized milk should not be eaten.
- Foods that have been cooked should be stored in the refrigerator at <4°C or 40°F. They should be consumed within 24 to 48 hours.

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