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Long-term Dietary Habits and Interventions in Solid Organ Transplantation

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Abstract

Diet and nutrition are moving to the forefront of modern primary and preventative care to help address the rising burden of chronic diseases amongst the general population. Such a movement has yet to occur formally across the field of transplantation. We therefore looked to establish the current base of knowledge regarding diet, nutrition and solid organ transplantation. A limited number of focused studies looking into the dietary habits of solid organ transplant patients have been performed and many of the available studies detail the nutritional status in the perioperative period. Frequently described, however, is the heavy incidence of metabolic abnormalities such as obesity, dyslipidemia and diabetes that occurs following solid organ transplantation. Optimistically, several studies noted improvement in several metabolic abnormalities with the use of dietary interventions in the posttransplant period. Despite these positive results, few consensus guidelines for posttransplant diet have been established and nutritional support amongst transplant programs remains limited. While there are many hurdles to implementation of detailed dietary recommendations and nutritional support for transplant patients, creating such programs and guidelines could dramatically impact long-term outcomes and burden of chronic metabolic disease for transplant recipients.

Keywords

Solid-Organ Transplantation; Diet; Intervention

Introduction

As diet and nutrition are quickly emerging in the battle against chronic inflammatory diseases, the potential exists to extend this front into the field of transplantation. Chronic diseases like obesity, diabetes, hyperlipidemia and hypertension pose a significant longterm health burden for solid organ transplant recipients^{1–8}. While major institutions such as the

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World Health Organization, United States Departments of Agriculture and Health and Human Services, American College of Preventive Medicine and the Center for Disease Control identified diet and nutrition as major avenues to address chronic diseases amongst the general population^{9–12}, our experience in addressing these chronic diseases through dietary interventions amongst solid organ transplantation is limited.

Information regarding post-transplant diet previously concentrated on re-operative and short term nutritional status, including the well documented malnutrition and micronutrient deficiencies of transplant recipients¹³. As a result, recommendations for post-transplant diet and nutrition currently focus on the acute phase post-transplant in the effort to promoting healing,¹⁴ while helping to prevent infection, support metabolic demands and replenish lost energy stores of the recipient,¹⁵ since metabolic demands after transplantation are typically well above normal levels¹⁶. Over the long term, however, the focus of dietary support should shift to the prevention of common chronic metabolic diseases like diabetes, dyslipidemia and obesity, while also managing chronic complications of graft rejection and immunotherapy¹⁷. Therefore, this review aims to highlight the studies that have evaluated diet and nutrition over the long term following transplant. We examine some previously established dietary interventions as a means to examine the current works in this area and the importance of future focus on longterm diet in solid organ transplantation.

Methods

We conducted a Pub Med database review of the current literature with the key words of “Diet” or “Nutrition” and “Transplantation” that appeared in either the title or abstract of the published work. The results list was then manually sorted for pertinent articles relating to solid organ transplantation. In total, 1417 articles published fit the intention of the original search, and a series of 113 articles published between 1983 and 2014 were identified as relevant for review. Articles were excluded from use in the review based on the following: 1) focus on short term diet or nutrition and/or 2) relating information that was relayed in more recent works. Subsequently, this review presents the findings of relevant articles that focus on long-term diet following solid organ transplantation.

Post-transplant dietary surveys

There are a limited number of studies into the long term dietary habits of solid organ transplant recipients, and examples of these studies can be found with liver, kidney and heart transplant recipients (Table 1). Each study typically employs a diet recall survey as the principal method to collect dietary and nutritional information regarding each patient. The published data from the majority of these studies typically focus on the consumption of large macronutrient categories such as total calories, carbohydrates and protein. Many of these studies additionally utilized other measures of nutritional status, including the mini nutritional assessment questionnaire (MNA), subjective global assessment (SGA) and anthropometric measurements.

Assessing dietary habits and macronutrients

Long term post-transplant dietary habits of transplant patients, focusing on the intake of calories and major macronutrients (lipids, carbohydrates, proteins), have been reviewed to a limited extent. For example a 2010 study of renal transplant recipients in Mexico used a 24-hour dietary recall survey to report the macronutrient consumption across these three lifestyle groups. Most diets contained a similar percentage of carbohydrates (55%), protein (15%) and fats (25%)¹⁸. In addition to this one-time view, de Luis and colleagues compared the nutritional status and diet intake prior to and following transplant¹⁹. Evaluating 31 consecutive liver transplant patients, diet habits were compared between 6 months prior to and 6 months following transplantation. Diet habits were measured with 3 day diet diaries and then compared with national composition food tables by a dietician. In this case, the determination was made that pre-transplant diets were “normal,” and dietary habits did not specifically change after liver transplantation. However, no description of the composition of the diets was made. Similarly, nutritional status was normal prior to transplantation and did not show any relation to post-transplant outcomes such as intensive care admissions or length of stay. While this study showed the similarities between pre- and post-transplant nutrition, the scope of this investigation did not extend at length into the post-transplant period.

Stretching farther after transplant than de Luis et al., several studies have evaluated the long-term nutritional status using post-transplant dietary habits. Flattery and colleagues gave the Lifestyle Profile II survey, containing 9 items related to basic dietary habits, to 126 patients after more than 12 months post heart transplantation²⁰. Researchers divided the patients into five groups; the last consisting of those at greater than 97 months post transplantation, and found that scores on the dietary component of the questionnaire remained fairly stable over the long-term post-transplantation. Importantly, participants in this study reported that they follow a heart healthy diet “sometimes,” and no information was provided about the composition of diets.

Two other studies provide more detailed information regarding long-term diet post-transplant. The first of these studies evaluated the nutritional status following 44 renal transplants with related outcomes of body composition²¹. In the study, a 3-day food record (prospective), followed by an interview with a dietician, was employed to describe overall energy intake up to 12 months following transplant. Reporting intake of macronutrients, the study found that dietary caloric and protein intake increased only in the female recipients. These increases in macronutrients in women were accompanied by increased fat and lean mass, which was proposed to be the result of multiple factors including energy intake, steroid doses, acute rejection and delayed graft function. Similarly, Ferreira et al. evaluated energy expenditure compared with dietary intake longitudinally following liver transplant for 17 patients up to 12 months post-transplant²². Using 3-day dietary records for nutritional intake measurement, there was a reported positive energy balance at all time-points following transplantation and a subsequent increase in weight and fat mass. The increase in fat mass and weight was attributed to an increasing intake of fat, while other macronutrients (proteins and carbohydrates) remained relatively stable, highlighting the potential link between post-transplant dietary changes and metabolic abnormalities like weight gain.

Micronutrient Evaluation and Supplementation

In addition to studies evaluating macronutrient intake over the long-term following transplantation, several studies have focused on micronutrient intake and supplementation. Heaf et al. evaluated post renal transplant diet using a similar 3-day diet history on 115 patients who were a mean of 6.6 years post-transplant²³. Major findings in this study reflected a diet high in fat and associated micronutrient deficiencies including folic acid, vitamin D, thiamine, iodine, selenium and iron. Du Plessis et al. similarly evaluated post-transplant micronutrient status and intake, but made a distinction between the short- (<28 months) and long-term phases (>28 months) post-transplant²⁴. Within this comparison, micronutrient intake typically improved in the long-term phase though paradoxically the prevalence of micronutrient deficiencies such as Vitamin C and Vitamin D increased over the long term. This trend demonstrates that while the dietary intake of some specific micronutrients by transplant recipients can improve overtime, the interplay of end organ function with micronutrients also plays a significant role in the determination of nutrient status.

In the context of such micronutrient deficiencies, there is little surprise in the prevalent use of dietary supplements amongst transplant recipients. Neff et al. identified from a group of 290 liver transplant recipients that 101 patients (35%) noted continuous use of vitamins, particularly a multivitamin, but also including vitamin B complex²⁵. The review subsequently identified 4 patients with elevated transaminase levels and primary biliary cirrhosis, all of whom were taking a high dose vitamin E supplement (>1,000mg/day). Elevated transaminase levels were also reported among patients who noted taking the herbal supplements colostrum (1 patient), Echinacea (2 patients) and noni juice (2 patients). Overall, 55 patients (19%) admitted to using herbal remedies post-transplant. The most common of such herbs was milk thistle (30 patients) and green tea (15 patients), but also noted were ginseng, garlic, chamomile, sage, St. Johns wart, licorice root, ephedra, Co-enzyme Q-10 and zinc. Importantly, many of these herbal supplements serve as immunostimulants and modulators or platelet adherence/aggregation. These two properties in particular may impact the development of post-transplant complications or graft dysfunction, particularly those with vascular etiologies. Additionally, it is noteworthy that current supplementation regimens by transplant patients are not addressing the likely micronutrient deficiencies, illustrating the need for a more targeted approach to the use of dietary supplements posttransplant.

Post-transplant Dietary Interventions

Despite the documented deficiencies in macro/micro-nutrition over the long-term post-transplantation, relatively few studies involving dietary interventions have been reported within the field of solid organ transplantation. These studies are currently limited to liver, heart and kidney transplantation, with the latter having the most detailed experience (Table 2). The type of intervention varies between general dietary recommendations and counseling to specific supplementation of diet. Presented below are these interventions organized by target post-transplant metabolic derangement.

Dietary Intervention and Post-transplant Dyslipidemia

Evidence from dietary interventions in kidney and heart transplantation demonstrates that dyslipidemia can be improved through dietary restrictions and modifications. Zaffari et al. demonstrated that 151 renal transplant recipients restricted to 25% of calories from lipids, with less than 10% coming from saturated fats and less than 500mg of cholesterol per day, showed reductions in plasma lipid profile among those who completed the 8 week diet (108 recipients, assessed by 24hr diet recall questionnaire)²⁶. In the study, serum LDL fell from 174mg/dL to 166mg/dL, while serum cholesterol dropped from 262mg/dL to 252mg/dL, though only 22 demonstrated reduction of serum cholesterol below 200mg/dL. While significant, the reductions attributed to dietary intervention were not sufficient to adequately control the recipients' dyslipidemia. This insufficiency could be attributed to the short duration of the dietary intervention in the study.

Subsequently, long-term dietary interventions using specific dietary plans have yielded improved lipid profiles following transplantation. For example, dietary interventions employing a 10–12 week Mediterranean diet (AHA step one diet with increased intake of monosaturated fats and alimentary fibers) for 78 renal transplant recipients demonstrated significant reductions in lipid profile with clinically relevant improvement²⁷. Lipid reductions included a drop of approximately 10% in total cholesterol, LDL and LDL:HDL ratio, while HDL cholesterol levels remained stable. Such reductions resulted in significantly increased percentage of recipients meeting requirements for the “desirable LDL-cholesterol class” (LDL < 129mg/dL), while fewer were classified under the “high-risk LDL-cholesterol class” (LDL > 162mg/dL).

Additional studies employing the AHA step one diet with encouragement of physical activity have yielded similar reductions in lipid profile even in the setting of statin use. Guida et al. with a series of 46 kidney transplant recipients in 2007 showed that those compliant with the same AHA step one recommended diet were shown to have a dramatic reduction in plasma lipids including a 30% reduction in cholesterol beyond the impact of concurrent statin use²⁸. Similarly, Guida et al. later demonstrated with 42 heart transplant recipients improvement in metabolic lipid profile, including decreased total serum cholesterol and triglycerides amongst those recipients compliant with the diet²⁹. Plasma lipid level reductions were also noted in patients currently receiving statins to an additional 10% beyond the impact of the medication. As a result of these experiences, diets with reduced saturated fat, balanced carbohydrates (50–60% of diet) and high amounts of plant sterols appear effective when recommended for diets aimed at post-transplant dyslipidemia.

Dietary Intervention and Post-transplant Weight

Many of the studies reporting reduction in plasma lipid profile additionally reported an impact of post-transplant dietary interventions on weight gain following transplantation. Renal transplant patients receiving the short-term limited lipid intake diet (25% calories from lipids with less than 10% from saturated fatty acids and less than 500mg cholesterol/day) displayed a modest reduction in body weight from a prediet mean of 68.98 kg to 67.78kg and BMI from 25.86kg/m² to 25.41kg/m² during the study period²⁶. Dietary

interventions over a longer period have demonstrated more significant reductions in body weight. For example, a 1-year low fat (less than 300mg/day cholesterol with 2:1 ratio of unsaturated:saturated fats), low protein (0.8–0.9g/kg/day of protein) hypocaloric diet for obese or overweight renal transplant recipients led to a reduction of post-transplant BMI to normal range (less than 25kg/m²)³⁰. Additionally, heart transplant recipients enrolled within 1-year post transplant who demonstrated compliance with the AHA step one diet displayed significantly lower weight (77.1±8.2kg) at 4 years into the study, when compared with those non-compliant with the dietary regimen (94.6±9.8kg), and a lower weight than the pre-intervention baseline (85.8±12.6kg). Heart transplant recipients enrolled into the intervention after the 1-year post-transplant time point did not show such significant reductions in weight when comparing compliant vs. non-compliant and compliant vs. baseline measurements.

Dietary intervention and Post-transplant Diabetes

While the impact of dietary interventions on other metabolic abnormalities following transplant have been well characterized, the impact of dietary interventions on post-transplant diabetes is limited. Heart transplant recipients who are compliant with the AHA step one guidelines, starting within the first year after transplantation, demonstrate decreased plasma glucose levels compared with those non-compliant and baseline levels²⁹. Subsequently, none of the diet-compliant recipients enrolled in the first year post-transplant showed diabetes mellitus at 12 or 48 months post dietary intervention, though 35% of this population had shown signs of diabetes. Conversely, diet-noncompliant recipients enrolled in the first year post transplant displayed increasing prevalence of diabetes mellitus to 50% and then 70% at 12 and 48 months post intervention, respectively, increasing from 40% at baseline. Interestingly, recipients enrolled in the intervention after one year post-transplant experienced a similar reduction in diabetes prevalence from 27% to 10% regardless of compliance. While a decrease in post-transplant diabetes was noted following diet among heart transplant recipients, a paradoxical increase in post-transplant diabetes was noted in the dietcompliant group of renal transplant recipients after 12 months²⁸. This increased prevalence of post-transplant diabetes mellitus (5/24 in diet-compliant group vs. 3/19 in non-compliant group) occurred despite improved glycemic control in the diet-compliant group. These data align with the multifactorial etiology of post-transplant diabetes mellitus but also reflect the importance dietary intervention to improving post-transplant diabetic disease.

Dietary Intervention and Graft Function

In addition to influencing post-transplant metabolic abnormalities, a link between diet and graft survival may exist. Bernardi et. al. examined the impact of a low protein, low salt and low lipid diet on post-transplant graft function among 86 renal transplant patients³¹. Within this study, the 68 patients who were found to be compliant demonstrated superior graft parameters (urinary urea excretion, urinary sodium, serum creatinine) than those non-compliant with the diet. While no measurements of overall graft survival were performed, this preliminary study suggests that correctly following a dietary intervention could positively influence graft function.

Current Guidelines

With a limited number of studies characterizing long-term diet and its influence on post-transplant complications and graft function, few guidelines have been developed to address long-term diet after transplantation. Much of the published guidelines to date have focused on peri-operative nutrition, including the set of global guidelines put forth in 2006 by the European Society for Parenteral and Enteral Nutrition³². Subsequently, many of the organ-specific international society guidelines for post-transplant management do not include recommendations for long-term dietary management despite mentioning the importance of countering the lasting effect of posttransplant metabolic disorders^{33–35}. Some recommendations for long-term posttransplant diet, however, have been made by individual reports. A 1980's reflection on nutritional management of cardiac transplant patients gives generalized dietary recommendations for calorie, sodium, fat and sugar intake in the context of metabolic abnormalities but does not reference any evidence behind these broad guidelines³⁶. More recent attempts at evidence based and targeted diet recommendations for transplant recipients have been made with kidney transplant recipients, though most sections are left without specific recommendations due to a lack of evidence³⁷. The lack of evidence and of standardized guidelines highlights the need for additional investigation to allow for the composition and distribution of long-term dietary guidelines for transplant recipients.

Discussion

Diet likely plays a significant role in the long term course of solid organ transplants, though a limited number of studies have been performed to evaluate this long-term impact. Solid organ transplant recipients are burdened by a high prevalence of chronic post-transplant metabolic diseases including diabetes, obesity and dyslipidemia. Addressing this burden, basic dietary interventions have been shown to be preliminarily effective at counteracting chronic diseases in solid organ transplant recipients over the long term though standardization of specific long-term dietary recommendations through published global guidelines remains scarce. Summarizing the current literature, several recommendations can be made about future long-term dietary models and investigations following solid organ transplantation (Box 1). Many challenges, however, continue to limit the effective and disseminated implementation of dietary recommendations despite the growing need amongst transplant recipients.

Box 1

Main Summary Points

- Dietary interventions should be in-place over the long term
- Start dietary intervention within 1 year of transplant
- Example recommendations include: Low fat diet, AHA step one diet, Mediterranean diet
- Accompany diet recommendations with diet counseling

A common challenge among dietary studies is obtaining compliance with the recommended diet among the target population. Studies included in this review typically reported non-compliance with dietary intervention of approximately 50%. Other studies among the heart transplant recipient population have found more optimistic rates of non-compliance with diet from 15–18%^{38–41} where non-compliance tended to significantly increase over the first year after transplant. Background health-related demographics showed no correlation with dietary compliance while pre-op psychosocial characteristics like emotional distress, low social support and use of avoidance coping strategies were strong predictors of non-compliance⁴⁰. Others found that difficulty with dietary compliance correlated with post-transplant factors such as self-care stress, GI distress symptoms and neuromuscular/dermatologic symptoms⁴¹. Conversely, compliance was positively correlated with motivation and severity of illness threat to the patient.

The issue of dietary compliance following transplantation likely depends on the extent of the dietary support programs employed by transplant centers. A late 1980s survey of 20 heart transplant centers regarding their nutritional support programs highlighted the practices and challenges facing dietary support of transplant recipients⁴². At the time 88% of centers assessed nutritional status post-transplant, relying heavily on patient provided history, and to a lesser extent, with laboratory values (visceral protein status, transferrin levels) and signs of nutritional deficiencies. Only 68% of centers, however, claimed to monitor nutrition following at out-patient follow up appointments. Additionally, while 80% of centers included dietitians in the transplant team, only 50% of programs included them in the pre-transplant teaching sessions when diet and nutrition was frequently discussed. In these sessions, education was mostly individualized (72% of centers) with limited incorporation of visual materials, videos and cooking classes. Most programs did make general diet recommendations (i.e., low fat, low cholesterol, low sodium) in accordance the National Cholesterol Education Program (NCEP) but did not make distinct efforts at monitoring compliance. This study highlighted the lack of resources and regimen necessary to conduct adequate dietary support and monitoring following transplantation, and called for the development of center specific guidelines. Standardization, however, of long-term dietary assessment of transplant recipients has yet to be implemented within or across institutions.

The lack of resources has similarly inhibited the implementation of dietary interventions among solid organ transplant recipients. A survey of dietitians working at renal transplant centers across Australia and New Zealand frequently cited low funding and an insufficient ratio of full-time dietitians to patients as reasons for the poor installation of dietary interventions post-transplant⁴³. The study suggests that a dietitian to patient ratio of 1:250 would be sufficient for dietary support, while the actual ratio was closer to 1:400. With insufficient personnel, longitudinal dietary education and monitoring is extensively impaired, particularly at high-volume primary transplant centers. This same study noted that at primary transplant centers, the dietary education is typically given on an inpatient basis while secondary transplant centers most often give this instruction through outpatient visits. It is likely that the quality of instruction and retention during the perioperative inpatient visit at large transplant centers is not sufficient to instill proper dietary habits following transplantation. Longitudinal sessions as an outpatient, like those employed by the smaller transplant centers, may be more efficacious. Additionally, outpatient visits could be

transformed from individual teaching into larger group education sessions as are employed successfully in wellness programs across the country for the general population.

As the scope of post-transplantation management continues to expand to include many chronic and nutrition related diseases, the practicality and efficacy of dietary intervention programs will be increasingly important. This is perhaps most prudent for the rising field of intestinal and multivisceral transplantation where digestion and absorption of nutrients may be directly affected by the transplantation. Many of these patients are started on enteral nutrition following transplantation and demonstrate adequate growth, nutrition and progression to oral diet^{44–46} over time, though few extended surveys of diet and nutrition have been conducted with intestinal transplant recipients⁴⁷. In the cases of non-intestinal solid organ transplantation, diet may be a primary factor in the development of post-transplant complications. Short-term diet supplementation with fish oil in animal and limited human models have shown reduced vasculopathy and rejection along with improved graft function in the setting of cyclosporine treatment among heart and kidney transplants^{48–52}. Other studies have employed vitamin D supplementation with low calcium diets to improve lung allograft function and reduce acute rejection in mice⁵³. These preliminary studies along with the evidence presented by Bernardi et al. demonstrate the potential of diet to not only impact the high incidence of metabolic derangements following transplantation but also to influence post-transplant complications and graft survival.

The potential impact of diet following transplantation extends widely in the setting of long-term management of solid organ transplant recipients, and further investigation must be done to illuminate these applications. These studies would be paramount to the creation of longitudinal dietary support programs and guidelines that could be targeted for the specific constellation of complications associated with each type of solid organ transplantation. While the reach of long-term diet interventions may prove large, it is equally important to acknowledge that this review highlights only a segment of the stages in transplantation, whereas diet may prove instrumental in many other areas including pre-transplant diet, donor nutrition and the role of gut flora along with transplant diet and nutrition. For now, preliminary data and experiences in a variety of solid organ transplants point to the meaningful and beneficial effect of organized and long-term dietary intervention following transplantation that must be further studied to help optimize post-transplant outcomes.

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Abbreviations

AHA	American Heart Association
NCEP	National Cholesterol Education Program
LDL	Low Density Lipoprotein
HDL	High Density Lipoprotein

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Table 1

Long term Diet/Nutrition Post-Transplant by Transplanted Organ

Study	#	Post Tx Study Design	Survey Method	Major Findings
Liver Transplant				
Neff et al. 2004 ²⁵	290	Mailed survey (variable time points)	Questionnaire (R)	Many Tx recipients were using vitamin supplements (50%) and herbal remedies (19%) Many herbal remedies are known immunomodulators
de Luis et al. 2006 ¹⁹	31	Nutritional evaluation at 6 months pre and 6 months post Tx	3-day diet diary ^C (P), SGA ^B assessment, MNA ^C	Dietary intake did not change after LTx
Ferreira et al. 2013 ²²	17	Nutritional and Anthropometric evaluation ^A at 1, 3, 6, 9, 12 months post-Tx	3-day diet record (P)	Excessive weight (64%) at end of study; attributed to excessive fat intake
Kidney Transplant				
Du Plessis et al. 2002 ²⁴	58	Evaluation of recipients <28 or >28 months post-Tx with Biochemical evaluation ^B , dietary survey, anthropometric measurements	Food Frequency Questionnaire (R)	Found Vitamin B ⁶ and B ¹² deficiencies, low magnesium
Haggan et al. 2002 ²¹	44	Evaluation at Tx, 3, 6 and 12 months post-Tx with anthropometric measurements, biochemical evaluation and diet records	3-day diet record (P)	Body composition during year 1 post-transplant was modulated by gender, energy intake, steroid doses, occurrence of rejection, delayed graft function
Heaf et al. 2004 ²³	97	Study of dietary habits and nutritional status. Mean 6.6 years post-Tx	3-day diet history (P)	diet was generally sufficient, but was characterized by a high fat intake and deficiencies in folic acid, vitamin D, thiamine, iodine, selenium, and iron intake
Pulgar et al. 2010 ¹⁸	119	Evaluation of consumption of macronutrients and life style – grouped by favorability of diet	1-day diet recall (R)	All groups displayed similar macronutrient consumption (50% carbohydrates, 15% protein, 25% lipids)
Heart Transplant				
Flattery et al. 2006 ²⁰	126	Evaluating lifestyle and health status over time (5 groups: from 1 - >6 years Post Tx)	Lifestyle Profile II survey (9 items on nutrition) (R)	Sometimes adherent to Heart healthy-dietary recommendations; concerns about obesity/overweight and suggested need for dietary surveys with portion sizes

Tx- transplant, SGA-Subjective global assessment of nutrition status, MNA- mini-nutritional assessment, P- prospective, R- retrospective

^A Anthropometric measurements include: body weight, height, BMI, triceps and subscapular skin fold thickness, arm circumference, arm muscle area and arm fat mass.

^B Biochemical Evaluation- Serum Protein, Serum cholesterol, Electrolytes, Complete Blood Count

^C Diet records typically requested patients to record food intake from weekdays and at least 1 weekend day.

Subjective Global Assessment-8 category, including 1 assessing dietary intake, tool to evaluate nutritional status based on history and physical examination⁵⁴

Mini-nutritional Assessment-18 question, including 6 dietary items, highly sensitive screening tool for nutritional status generally employed in the elderly⁵⁵

Table 2

Dietary Interventions Post-Transplant by Transplanted Organ

Study	#	Intervention Design	Survey Method	Compliance ^A	Analysis	Major Findings
Liver Transplant						
Krasnoff et al. 2006 ⁵⁶	119	Randomized trial of 1 year exercise and dietary counseling based on NCEP guidelines ^B (Extended Care) vs. usual care	At Baseline- Block 95 item Questionnaire (R) Time Points-3 day diet records (P)	37%	Extended Care vs. Usual Care (intent to treat) Ad Hoc- Effect of Compliance	Similar diet profiles with slight decrease in calories from Fat over time in Extended group; no differences with comparison by compliance
Kidney Transplant						
Barbagallo et al. 1999 ²⁷	78	Effects of 10–12 week Mediterranean diet on post- Tx lipid levels and cardiovascular risk	Dietary Recall (R)	NR	Effect of Patients groups based on NCEP LDL risk groups ^C	Reduction in in total cholesterol, LDL and LDL:HDL ratio while HDL cholesterol levels remained stable. Increased percentage of recipients meeting Requirements for the “desirable LDL” category with fewer in the “high-risk LDL” category
Zaffari et al. 2004 ²⁶	108	8 week dietary intervention (Low fat) for effects on hyperlipidemia	24 hour Dietary Recall (R)	50%	Effect of Time (Pre/Post- Intervention)	Significant reductions in serum cholesterol, LDL but not sufficient to control hyperlipidemia. Associated significant reductions in body weight and BMI.
Guida et al. 2007 ²⁸	46	12 month dietary intervention (AHA step 1 diet, protein restriction, salt restriction) with exercise in post-Tx abnormalities and nutritional status	130 item Food Frequency Questionnaire (P)	54%	Effect of Time Effect of Gender Effect of Compliance	Compliance (males >females) was related with weight loss (decrease in fat mass), and decrease in total cholesterol and glucose. Reduction of 30% in cholesterol beyond impact of statins. Paradoxical increase in Post-Tx Diabetes in diet group
Bellingheri et al. 2009 ³⁰	182	12 month dietary intervention (low protein, low sodium, low calorie) on Metabolic Syndrome components.	NR	NR	Effect of Time	Reduction in BMI of patients to normal range (<25kg/m ²) following initial rise after 1 year post-Tx
Bernardi et al. 2005 ³¹	86	Evaluation of diet post-Tx as it relates to graft function over 14 months (protein and salt restricted)	2-day diet record (P)	79%	Effect of compliance	Adequate compliance with diet led to improved Renal graft function compared with non-compliant
Heart Transplant						
Guida et al. 2009 ²⁹	42	4 year dietary intervention (AHA step 1 diet) + exercise on metabolic outcome: Divided into <28 months post-Tx or >28 months post-Tx	130 item Food Frequency Questionnaire (P)	50%	Effect of Time Effect of Compliance	Noted improved lipid profile, glucose plasma level and weight loss due to a decrease in fat mass Cholesterol level reduced by additional 10% in patients on statins

Tx- transplant, P- prospective, R- retrospective, NR- not reported

^A Compliance with the dietary intervention amongst intervention group assessed by specified survey method^B National Cholesterol Education Program (NCEP) published guidelines for risk stratification based on serum lipids and subsequent treatment recommendations that included dietary guidelines⁵⁷

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C NCEP risk levels: “Desirable LDL” (LDL < 129mg/dL), “borderline high risk LDL” (129mg/dL < LDL < 162mg/dL), “high risk LDL” (LDL > 162 mg/dL)

Table 3

Summary of Dietary interventions

Dietary Intervention	Components	Studies Using such recommendations
NCEP^A guidelines⁵⁸	Less than 10% of total calories from saturated fatty acids Average of 30% of total calories or less from all fat Less than 300mg cholesterol per day Dietary energy levels needed to reach or maintain desirable weight	Krasnoff et al. 2006⁵⁶ Barbagallo et al. 1999²⁷
“Mediterranean Diet”⁵⁹	Monounsaturated to saturated fatty acid ratio (range: 1.6 to 2.0) Intake of dietary fiber (41 to 62 g/person/day) Antioxidant capacity of the whole diet (3500 to 5300 trolox equivalent/person/day); Phytosterols intake (370 to 555 mg/person/day).	Barbagallo et al. 1999²⁷
“Low Fat”	25% Energy Intake from lipids <10% Energy intake from Saturated fatty acids <500mg cholesterol per day	Zaffari et al. 2004²⁶
“Low Calorie”	Consuming fewer calories than daily expenditure, patient specific.	Bellingheri et al. 2009³⁰
“Low Sodium” (Salt Restriction)	1.5 g/day of sodium content in foods <3 g/day of additional salt	Bellingheri et al. 2009³⁰ Bernardi et al. 2005³¹ Guida et al. 2007²⁸
“Low Protein” (Protein Restriction)	0.8–0.9 g/kg/day	Guida et al. 2007²⁸ Bernardi et al. 2005³¹ Bellingheri et al. 2009³⁰
“AHA step 1 diet”^B	Intake of macronutrients (% of total Calories): 55% carbohydrates, 15% protein, 30% total fat Energy intake of greater than 25/kcal/kg/ideal body weight/day	Guida et al. 2007²⁸ Guida et al. 2009²⁹

^A More details about the NCEP dietary guidelines and recommendations are available⁵⁷

^B The AHA step 1 diet for the general population and step 2 diet for high risk populations originally modeled the NCEP dietary recommendations and have since been updated⁶⁰