OREGON HEALTH & SCIENCE UNIVERSITY
SCHOOL OF MEDICINE – GRADUATE STUDIES

THE IMPACT OF NUTRITION EDUCATION ON POST SURGICAL WEIGHT MAINTENANCE AND GLYCEMIC CONTROL AMONG RENAL TRANSPLANT PATIENTS

By

Amanda Rosenberg

Presented to the Faculty of the Graduate Programs in Human Nutrition
and the Oregon Health & Science University
School of Medicine

Master of Science in Clinical Nutrition

June 2015

OREGON HEALTH & SCIENCE UNIVERSITY

SCHOOL OF MEDICINE – GRADUATE STUDIES

School of Medicine

Oregon Health & Science University

CERTIFICATE OF APPROVAL

This is to certify that the Master's Thesis of

Amanda Rosenberg

has been approved

_____

Maureen McCarthy, MPH, RD, LD

_____

Diane Stadler, PhD, RD, LD

_____

Michael Lasarev, MS

Table of Contents

Acknowledgements

This thesis would not have been possible without the help of my mentor, Maureen McCarthy, and my committee members, Dr. Diane Stadler and Mike Lasarev. I deeply appreciate all of the time and efforts put forth by all of my committee members. I would like to thank Dr. Diane Stadler and Maureen McCarthy for their encouraging presence throughout this experience. In addition to my committee members, I would also like to thank the entire transplant team at OHSU, without their flexibility and patience, this thesis would not be possible.

I would like to thank my wonderful husband, David Rosenberg, for his love and support no matter how stressed I became and for always reassuring me. I would like to thank my son, Mason Rosenberg, for forcing me to stop and smell the roses, no matter how busy or stressed I was. I would like to thank my older sister, Samantha May, for her encouragement and occasional sass. I would like to thank my father, Todd Bacastow, whom I feel his love and pride from Heaven. I am also extremely grateful for my entire family, who have been a constant source of support throughout my life.

LIST OF ABBREVIATIONS AND ACRONYMS

BMI	Body Mass Index
CVD	Cardiovascular Disease
DM	Diabetes Mellitus
ESRD	End Stage Renal Disease
HLA	Human Leukocyte Antigen
IRB	Institutional Review Board
NIH	National Institutes of Health
NODAT	New-Onset Diabetes after Transplant
OHSU	Oregon Health & Science University
RDN	Registered Dietitian Nutritionist
T2DM	Type 2 Diabetes Mellitus

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Background

New Onset Diabetes After Transplant (NODAT) is a complex disorder linked to risk factors such as obesity, post-transplant weight gain, and corticosteroid and immunosuppressive agents used after transplant. Non-pharmaceutical interventions that help patients maintain weight and glucose control are needed to lower the risk of developing NODAT.

Objectives

1. To determine the impact of nutrition education on post-surgical weight control in kidney transplant recipients who gain weight within two weeks of transplantation.
2. To determine the impact of nutrition education on post-surgical glycemic control in kidney transplant recipients with pre-existing Type 2 diabetes mellitus or who develop new-onset diabetes after transplantation.

Methods

We measured the effect of nutrition education on the maintenance of body weight and glycemic control in kidney transplant recipients (n=7) compared to propensity score-matched historical controls (n=14) who received kidney transplants at the same institution but did not receive nutrition education. Weight, immunosuppressant and

diabetes treatment regimen, plasma creatinine concentrations, and glomerular filtration rate were measured before, at hospital discharge, and six and twelve weeks after transplant. Participant-centered nutrition education began with open-ended questions about the participants' current diet, while incorporating how the nutrition education handout could be implemented for that patient, and completing the session with a patient generated S.M.A.R.T. goal. Nutrition education was based on The Plate Method promoted by the American Diabetes Association and was delivered two weeks after transplant surgery.

Results

The intervention group lost 0.89 ± 4.5 kg (p=0.66) from hospital admission to week 6 post-transplant and gained 3.4 ± 3.6 kg (p=0.03) from week 6 to week 12 post-transplant. The control group lost 1.1 ± 5.6 (p=0.43) from hospital admission to week 6 post-transplant and gained 3.6 ± 3.9 kg (p=0.002) from week 6 to week 12 post-transplant. Between hospital admission to week 6, there was a 0.24 kg (standard error 2.4, p=0.92) difference in post-transplant weight loss between the control and intervention groups. Between weeks 6 to 12, there was a 0.18 (standard error 1.7, p=0.92) difference in post-transplant weight gain between the control and intervention groups.

Of the 7 participants enrolled in the intervention group, 4 participants who had type 2 diabetes mellitus (T2DM) prior to transplant and 1 participant was developed NODAT. From hospital admission to discharge, 2 participants with T2DM had a

worsening and 2 participants had no change of diabetes treatment regimen; the participant who had NODAT had a worsening of diabetes treatment regimen. From discharge to week 6, 3 participants had a worsening and 1 participant had an improvement in diabetes treatment regimen; the participant who had NODAT had a worsening of diabetes treatment regimen. From week 6 to 12, 2 participants had no change and 2 participants had an improvement in diabetes treatment regimen; the participant who had NODAT had no change in diabetes treatment regimen. Whether a participant achieved his/her S.M.A.R.T. goal did not affect post-transplant weight maintenance or glycemic control.

Conclusions

1. Regardless of receiving nutrition education, kidney transplant recipients in both the control and intervention groups followed the same weight trajectory over the 12 week study period.
2. Participants who received nutrition education on glycemic control maintained or improved their diabetes treatment regimen by week 12. These results validate the need for early post-transplant interventions to assist recipients in maintaining blood glucose levels to decrease risk of cardiovascular and infection related death.

Chapter 1

Introduction and Significance

Kidney transplant, the gold standard for the treatment of end stage renal disease (ESRD), is more cost effective and provides a better quality of life compared to hemodialysis and peritoneal dialysis (1). From July 2013 to June 2014, 16,901 adult renal transplants were performed in the United States, 422 occurred in Oregon, and 182 occurred at the Oregon Health & Science University Hospital and Clinics (OHSU) (2). Diabetes mellitus (DM), the most common cause of kidney failure, accounts for 29% of end stage renal disease in the United States (3). Additionally, a common post-transplant complication is new-onset diabetes after transplantation (NODAT). NODAT is the development of diabetes mellitus in a previously non-diabetic individual after having an organ transplant (4). Approximately 2-52% of kidney transplant recipients are diagnosed with NODAT (4). This wide range of diagnosis may be due to the historic lack of standardization of NODAT definition (4-6).

NODAT is a complex disorder that involves modifiable risk factors such as obesity, post-transplant weight gain, corticosteroid and immunosuppressive agents, and post-surgery stress. Non-modifiable factors including age, race, sex, and a family history of DM also contribute to the risk of developing NODAT. In some studies, obesity was also associated with lower rates of patient and graft survival (7, 8). Other research reports that obese kidney transplant recipients had longer post-transplant hospital stays and increased complications post-transplant, but patient and graft survival rates were similar to non-obese kidney transplant recipients (9). Nutrition

education has been shown to positively impact obesity and type 2 diabetes mellitus (T2DM) in the general population, but the literature on how nutrition education impacts the management of NODAT among kidney transplant recipients and its outcomes are limited (10-12).

Hypothesis

We hypothesized that kidney transplant recipients with type 2 diabetes mellitus, who develop new onset diabetes after transplantation, or who gain weight within two weeks of transplantation and who receive nutrition education on weight management and/or glycemic control, will maintain or lose weight and/or maintain or improve their diabetes treatment regimen compared to a matched controls who do not receive post-transplant nutrition education.

Specific Aims

Aim 1: To determine the impact of nutrition education on post-surgical weight trends in kidney transplant recipients who gain weight within two weeks of transplantation.

Aim 2: To determine the impact of nutrition education on post-surgical glycemic control in kidney transplant recipients with pre-existing type 2 diabetes mellitus or who develop new-onset diabetes after transplantation.

Chapter 2

Background

The first aim of this study is to determine the impact of nutrition education on post-surgical glycemic control in kidney transplant recipients with pre-existing type 2 diabetes mellitus or who develop new onset diabetes after transplant. The second aim of this study is to determine the impact of nutrition education on post-surgical weight control in kidney transplant recipients who gain weight within two weeks of transplantation. Participants who receive nutrition education were compared to matched historical transplant recipients who did not receive post-transplant nutrition education.

Obesity and New-Onset Diabetes After Transplantation

The National Institutes of Health (NIH) define obesity through body mass index (BMI). A BMI less than 18.5 kg/m^2 is defined as underweight, from 18.5 to 24.9 kg/m^2 is defined as normal weight, from 25 to 29.9 kg/m^2 is defined as overweight, from 30 to 39.9 kg/m^2 is defined as obese, and greater than 40 kg/m2 is defined as extreme obesity (13). The prevalence of pre-transplant obesity in kidney transplant recipients increased 116% between 1987 and 2001 in the United States (7, 14). This increase may be due to the historic lack of a definition for obesity in the kidney transplant literature and/or the increased prevalence of obesity in the general US population.

Cacciola, et al., examined the effect of an obese BMI on renal transplant outcomes. Researchers divided kidney transplant recipients into two groups for their study: those who with a BMI between 30 kg/m^2 and 34.9 kg/m^2 (n=90), and those who with a BMI of 35 kg/m^2 or higher (n=24). There was no statistical difference between the two groups for incidence of wound infection, 22% vs 23% of participants. However, those with a BMI $\geq$ 35 kg/m^2 had significantly higher rates of mortality and graft failure. Individuals with a BMI between 30 kg/m^2 and 34.9 kg/m^2 had a 1 year survival rate of 98.9% and a 5 year survival rate of 95.6%. Those with a BMI of 35 kg/m^2 had a 1 year survival rate of 87.5% and a 5 year survival rate of 79.2%. The survival difference between groups was statistically significant at both 1 and 5 years (p=0.01) (8).

Grosso, et al., examined the effect of obesity (BMI >30 kg/m^2) on graft loss and patient mortality in kidney transplantation at one and three years. Researchers observed that overall obese kidney transplant recipients experienced increased rates of graft loss and patient mortality compared to non-obese kidney transplant recipients. At one year, obese recipients had a 1.1% higher rate of graft loss and a 4.2% higher rate of mortality compared to non-obese recipients. At three years, obese recipients had a 35.2% higher rate of graft loss and a 34.4% higher rate of mortality compared to non-obese recipients. Grosso, et al., also discovered that kidney transplant recipients who were obese prior to transplant (BMI >30 kg/m^2) had rates of graft loss six times higher at three years post-transplant than recipients who were not obese before transplant (BMI $\leq$ 30 kg/m^2). Researchers concluded that having a pre-

transplant BMI higher than 30 kg/m^2 was associated with decreased graft and recipient survival (7). Nevertheless, this remains an area of controversy.

Some research suggests that obesity should not be a contraindication to transplantation. Marks, et al., examined outcomes of non-obese (BMI $\leq$ 25 kg/m^2), overweight/obese (BMI $\geq$26 to $\leq$ 34 kg/m^2), and morbidly obese (BMI $\geq$ 35 kg/m^2) kidney transplant recipients. The 3-year graft survival of deceased donor organs was 90% for non-obese recipients and 75% for morbidly obese recipients (p=0.09). The 3-year graft survival of living donor organs was 91% of non-obese recipients and 100% of morbidly obese recipients (p=0.2). The length of hospital stay was significantly longer for morbidly obese recipients than non-obese recipients ($p < 0.05$). The readmission rate within the first 6 months after transplant was greater for the morbidly obese recipients than for non-obese recipients, but this was not statistically significant. Lastly, morbidly obese kidney transplant recipients presented with a higher rate of major wound infection, 30% vs 3% of non-obese recipients. Marks, et al., concluded that although morbidly obese kidney transplant recipients have longer hospital stays, higher hospital readmission rates, and higher rates of wound infection, the patient and graft survival rates are similar to non-obese recipients; therefore transplantation should not be contraindicated (9).

Obesity has also been linked with better outcomes for patients who have end stage renal disease (ESRD). Kalantar-Zadeh, et al., identified that a higher BMI and a higher serum creatinine concentration were independently associated with higher survival rates in patients diagnosed with ESRD and who were receiving hemodialysis. The researchers suggested that a heavier weight in conjunction with increased muscle

mass may be associated with a greater survival benefit (15). Fleischmann, et al., determined that individuals with ESRD with an overweight or obese BMI had better survival outcomes than those with a normal weight or underweight BMI. In addition to a higher survival rate, researchers, observed that patients who were overweight and obese had significantly higher levels of serum albumin, prealbumin, transferrin, and creatinine, and a lower rate of hospital admission than underweight patients (16). Johansen, et al., observed that higher adiposity was associated with an increased survival in individuals with ESRD (17). This paradox is not limited to ESRD, it has also been described in other areas of clinical practice, including oncology and heart failure.

Gill, et al., compared the outcomes of kidney transplant recipients to ESRD patients on dialysis. Researchers found that recipients who were obese prior to transplantation (BMI $\geq$ 30 kg/m^2) had significantly higher survival rates compared to ESRD patients who were obese on dialysis. The benefit of higher adiposity ceases at a BMI of 40 kg/m^2, such that pre-transplant recipients with extreme obesity, or a BMI $\geq$ 40 kg/m^2, did not acquire a greater survival benefit from transplantation compared to patients in the same weight category who remain on hemodialysis (18). There is minimal research on whether kidney transplant recipients who were obese prior to transplantation show worse short-and/or long-term graft and survival rates compared to kidney transplant recipients who were not obese prior to transplantation (7).

Recent research by Cullen, et al., demonstrated that a higher in BMI pre-transplant is associated with a higher incidence of NODAT. This research preceded this current research study. In this retrospective chart review, 10.5% of kidney

transplant recipients developed NODAT by discharge from the hospital, 8.2% developed NODAT by 3 months post-transplant, 3% developed NODAT by 6 months post-transplant, and 1.5% developed NODAT by 12 months post-transplant. Transplant recipients were categorized into pre-transplant BMI categories: normal BMI (BMI 18.5 kg/m^2 to 24.9 kg/m^2), overweight BMI (BMI 25 kg/m^2 to 29.9 kg/m^2), and obese BMI (BMI 30 kg/m^2 to >40 kg/m^2). The mean pre-transplant BMI was 27.3 ± 4.8 kg/m^2. Being obese (BMI >30 kg/m^2) prior to transplantation was associated with increased incidence of NODAT at discharge and at 3, 6 and 12 months post-transplant (1). In summary, several studies demonstrate that pre-transplant obesity offers a protective factor for patient morbidity and mortality and that obesity should not contraindicate kidney transplantation. However, weight gain after transplant and/or obesity may increase the risk of NODAT.

Body Mass Index and Transplantation

Due to the increased risk of complications among obese kidney transplant recipients, most kidney transplant centers have an upper BMI limit for transplant eligibility. Oregon Health & Science University Hospital and Clinics (OHSU) has established a BMI greater than 35 kg/m^2as a relative contraindication for transplant; some transplant centers have an upper limit BMI of 40 kg/m^2 (7). As described previously, a BMI greater than 30 kg/m^2 is a significant risk factor for graft failure and recipient death, but this is still an area of ongoing research (7).

New-Onset Diabetes After Transplantation

NODAT was first described by Starzl as 'steroid diabetes' in 1964 (19). It has many similarities to T2DM, one of which is that kidney transplant recipients may be asymptomatic for years before clinical symptoms are documented (20). The onset of NODAT can range from 3-4210 days after transplantation (5). Although the range of onset is very broad, the first three months after transplantation is the most common time frame (1, 5). The timing of NODAT is typically divided into two distinct phases: the first six months post-transplant and the time thereafter. Incidence begins to decline progressively six months after transplantation (20).

Demirci, et al., described several types of NODAT: early, late, transient, and sustained. Early NODAT occurs within first three months of transplantation; late NODAT occurs at least three months after transplantation. Transient NODAT occurs when the duration of diabetes is less than three months and sustained NODAT occurs when the duration of diabetes is longer than three months. The researchers observed that NODAT occurred in 18.2% of transplant recipients within 342 ± 640 days after transplantation. Of those who developed NODAT, 25.5% developed NODAT in the first three months, 24.5% in three to twelve months, 15.2% developed NODAT between one and three years, and 34.8% between three and 10 years after transplantation (5).

Risk Factors for New-Onset Diabetes After Transplantation

NODAT has several risk factors that are modifiable and others that are not. The latter include black or Hispanic ethnicity, age > 40 years, family history of diabetes mellitus, hepatitis C infection, recipient of a deceased donor kidney, a recipient of a male donor kidney, presence of polycystic kidney disease, and a human leukocyte antigen (HLA) mismatch (6, 20-26). Modifiable risk factors include immunosuppressive therapy regimen, a BMI greater than 35 kg/m^2, pre-transplant glucose intolerance, post-transplant weight gain, and presence of metabolic syndrome (6, 7, 20-23, 25, 26).

Diagnostic Criteria for New-Onset Diabetes After Transplantation

In 2003, an International Consensus Guideline was published for the definition of NODAT. These recommendations were later validated through discussion by members of an International Expert Panel (20). This document suggests the following criteria for the diagnosis of NODAT: symptoms of diabetes plus casual plasma glucose concentration ≥ 200 mg/dL. The classic symptoms of diabetes mellitus include polyuria, polydipsia, and unintentional weight loss. Diagnosis is confirmed by a fasting plasma glucose concentration ≥ 126 mg/dl, where fasting is defined as no caloric intake for at least eight hours prior to blood sample collection, or a two hour plasma glucose concentration ≥ 200 mg/dl after an oral glucose load of 75 grams anhydrous glucose dissolved in water (20). Casual, or non-

fasting/random, is defined as a blood sample taken at any time of day without regard to time since the last meal.

Pathophysiology of New-Onset Diabetes After Transplantation

The pathophysiology of NODAT is complex and multifaceted. Immediately after transplant, post-surgical stress, as well as the administration of corticosteroids and immunosuppressant medications, has a detrimental effect on pancreatic β cell function (27). Decreased β cell function leads to decreased insulin secretion which causes post-transplant hyperglycemia (27). Fridlyand, et al., proposed that glucose-dependent insulin secretion is linked to increased reactive oxygen species production from the electron transport chain and oxidative stress in pancreatic β cells (28). Therefore, in addition to early post-transplant hyperglycemia, oxidative stress can lead to glucotoxicity (28). The long term effects of chronic hyperglycemia lead to β cell degradation, which leads to a reduction of insulin secretion (29). In addition to decreased β cell function, immunosuppressive medications interfere with the nuclear factor of activated T-cell signaling pathway (30). This signaling pathway leads to the expression of genes that are critical for β cell function (30). As immunosuppressive medications are tapered, this signaling pathway resumes, and is associated with the resolution of transient NODAT.

Plasma Glucose and New-Onset Diabetes After Transplantation

Plasma glucose concentrations pre- and immediately post-transplant may be an indication of NODAT risk. Joss, et al., demonstrated that kidney transplant recipients who developed NODAT had higher mean random plasma glucose concentrations before transplant, on the first and seventh day after transplant, compared to recipients who did not meet diagnostic criteria. Among those who met diagnostic criteria, 44% of recipients required modifications in diet and 58% required medications to manage blood glucose. Researchers concluded that recipients who were obese prior to transplantation and who had higher pre-transplant mean random plasma glucose concentrations were more likely to develop NODAT (6).

Cardiovascular Disease and New-Onset Diabetes After Transplantation

Cardiovascular disease (CVD) is a major cause of morbidity and mortality after kidney transplantation. By 36 months post-transplant, 40% of transplant patients experience cardiovascular-related events, such as acute myocardial infarctions and congestive heart failure (31). This relationship is evidenced by an increased incidence of myocardial infarction in kidney transplant recipients compared to the non-transplant population (5, 6, 20). Transplant recipients who are diagnosed with glucose intolerance, have an increased incidence of myocardial infarctions and have a 6.4-fold higher risk of death from ischemic heart disease than do non-diabetic transplant recipients (5, 20, 24). It is unclear why transplant recipients who develop

NODAT are at greater risk for CVD, but it is understood that in the non-transplant population hyperinsulinemia and glucose intolerance are risk factors for CVD (20).

Type 2 Diabetes Mellitus and Transplantation

Diabetes mellitus is the most common cause of kidney failure, accounting for 29% of end stage renal disease in the United States (3). Rocha, et al., compared the outcomes of diabetic and non-diabetic kidney transplant recipients. In this retrospective chart review, 24.2% of diabetic recipients and 17.7% of non-diabetic recipients experienced graft rejections. Additionally, there was a significant difference in survival between transplant recipients with and without diabetes. At 5 years post-transplant, diabetic recipients had a 69% rate of survival, whereas non-diabetic recipients had a 96% rate of survival. At 10 years post-transplant, diabetic recipients had a 50% rate of survival, compared to non-diabetic recipients had an 84% rate of survival. Rocha, et al., concluded that T2DM is a significant predictor of transplant recipient death and that T2DM negatively impacts patient mortality (32).

Nutrition Education and Weight Management

Nutrition education has been shown to aid in weight loss and weight management. Salinardi, et al., evaluated the use of a weight-loss curriculum in worksite wellness programs. Researchers utilized a meal plan that was focused on portion control, contained ≥40 g dietary fiber per day, and with a macronutrient distribution of 25% protein, 27% fat, and 48% low-glycemic index carbohydrates.

Education was delivered by nutritionists through nineteen 60-minute bi-weekly education sessions. Participants who completed the educational sessions were encouraged to re-enroll in a 6-month maintenance program that was identical to the original program except that the groups met once per month. Intervention participants had an 8.0 kg ± 0.7 kg weight reduction after 6 months of nutrition education, whereas control participants had a 0.9 kg ± 0.5 kg weight gain. The researchers concluded that nutrition education can promote substantial weight loss and improve cardiometabolic risk factors in individuals that are overweight or obese (33).

Almeida, et al., investigated the effectiveness of a weight loss intervention for diabetes prevention. 1030 participants took part in the intervention arm of the study, which not only included recommendations for a healthful diet and physical activity, but also utilized social cognitive factors, such as increasing self-efficacy, reducing barriers to physical activity, and identifying rewards for a healthful lifestyle. Additionally, participants created personal action plans that included personal goals for physical activity, healthful eating, weight loss, as well as personal reasons for wanting to avoid diabetes and strategies to decrease barriers to achieving the physical activity and dietary goals. Body weight was measured at 12 months after the start of the intervention and was decreased significantly: 3.0 lbs average weight loss for intervention participants and 1.4 lb average weight loss for control participants. Researchers found that 22% intervention participants lost at least 5% of their body weight compared to 15% of control participants, thus intervention participants were 1.5 times more likely to lose at least 5% of their body weight than matched controls.

The researchers concluded that although the results were modest, weight loss intervention may enhance long-term weight loss efficacy (34).

Lopes, et al., investigated the use of the American Heart Association's Step One Diet for weight loss among kidney transplant recipients. The Step One Diet recommended <30% of calories from fat, <10% of calories from saturated fat, and <300 mg of cholesterol per day. In addition to following the Step One Diet, intervention participants were instructed to decrease their calories by 30%, which led to an average energy intake of 1,306 ± 25 calories per day. Researchers observed a mean weight loss of 3.2 ± 2.9 kg within 6 months. Lopes, et al., concluded that dietary modification should be considered as a first step in the treatment of obesity among kidney transplant recipients (35).

Nutrition Education and Type 2 Diabetes Mellitus

Nutrition education has been shown to aid in glycemic control among individuals with T2DM. Burani, et al., evaluated the inclusion of low-glycemic index carbohydrates into daily meal planning to improve glycemic control and weight management in patients with Type 1 Diabetes Mellitus and T2DM. Researchers utilized the 10-question Glycemic Index Foods Quiz (GIFQ) and the 29-question Interview Questionnaire (IQ). The IQ looked at patients' knowledge, facility implementation, and patients' perceptions of diet changes. Researchers observed a mean decrease of 1.5% ($p = <0.00$) in hemoglobinA1C values, a mean weight loss of 17 lbs ($p=0.002$), and in some participants, a decrease in insulin usage. Burani, et al.,

concluded that individuals with type 1 and type 2 diabetes mellitus could benefit from incorporating low glycemic index carbohydrates into their daily food choices, as well as that nonthreatening, practical behavior-centered nutrition information to assist in dietary guideline acceptance and motivation for change in patients with diabetes (36).

Yuan, et al., assessed the effect of diabetes self-management education on metabolic markers and atherosclerotic parameters in patients who were diagnosed with T2DM. Intervention participants received standard medical nutritional therapy as well as education on building skills and knowledge for healthy eating, being active, monitoring blood glucose, taking medications appropriately, problem solving skills, reducing risks, and health coping skills. Individuals who completed the diabetes self-management education series, with standard medical nutritional therapy, achieved a 0.2% ± 0.6% ($p=0.004$) reduction in hemoglobin A1C serum levels and a 1.19 kg ± 1.39 kg ($p=0.036$) reduction in body weight. Control participants, who received only standard medical nutrition therapy, obtained a 0.08% ± 0.741% ($p=0.004$) reduction in hemoglobin A1C serum levels and a 0.61 kg ± 2.04 kg ($p=0.036$) reduction in body weight. Researchers concluded that diabetes self-management education could significantly improve glycemic and body weight control (12).

Adachi, et al., examined the effect of lifestyle intervention by registered dietitian nutritionists (RDN) for T2DM in Japan (37). The individual-based lifestyle education intervention included encouraging a reduction in energy intake at evening meal and an increased intake of vegetables at breakfast and lunch. A reduction in energy intake at the evening meal was chosen in this study due to decreased physical activity in the evening. In addition to nutrition education, participants received

support for self-management of glycemic control through diet and exercise and stress management. Researchers observed a statistically significant improvement, -0.7%, in hemoglobin A1C values but did not observe a statistically significant change in weight and BMI. A large energy intake at dinner and a larger fat intake at dinner were correlated with an increase in hemoglobin A1C value, whereas increased vegetable intake at breakfast and throughout the entire day was correlated with reductions in hemoglobin A1C values (37). Although increased vegetable intake at breakfast was correlated with a reduction in hemoglobin A1C, this approach may not be well received in an US population. Adachi, et al., concluded that individualized lifestyle education for glycemic control by RDNs may help to improve glycemic control in patients with T2DM (37).

Although nutrition education can be effective in diabetes management, there are multiple barriers to implementing nutrition education. Barriers to nutrition education include patient concerns about changing habits, negative perception of dietary changes, feeling overwhelmed by multiple dietary changes, and access to nutrition education. Small, manageable changes, and repeated exposure to information and education can assist patients in overcoming barriers and allow an individual to become successful in diabetes management (38). Miller, et al., established that individuals who were able to form a knowledge base to build upon slowly had greater success at glycemic control than those in a conventional social cognitive theory based program (39). In conclusion, nutrition education as part of a lifestyle intervention may aid in the improvement in hemoglobin A1C values and glycemic control (12, 36, 37).

Nutrition Education and New-Onset Diabetes After Transplantation

NODAT is a multifaceted and complex post-transplant complication that has modifiable risk factors, such as pre-transplant obesity and post-transplant weight gain, which can be improved by nutrition education. Sharif, et al., enrolled 122 kidney transplant recipients and conducted a lifestyle modification intervention with a RDN. Lifestyle modification included nutrition education, physical activity, and glucose monitoring education. Nutrition education was based on guidelines issued by Diabetes UK, which recommends a low fat, high fiber diet, based on the framework of 50% carbohydrate and 25% protein. Researchers utilized a graded exercise program that recommended a minimum of two hours of endurance exercise, such as walking, jogging, and swimming per week. Participants were monitored and diet and physical activity guidelines were reinforced. Of the seven participants who were diagnosed with NODAT and received the lifestyle modification invention, two were able to obtain normal serum glucose concentrations and two met the criteria for impaired serum glucose tolerance, but did not meet the criteria for NODAT. Of 25 participants with impaired glucose tolerance who received lifestyle modification, 11 were able to maintain normal serum glucose concentrations, 13 maintained impaired serum glucose tolerance, and one participant developed NODAT. Sharif, et al., concluded that lifestyle modification in kidney transplant recipients can assist in the reversal of NODAT and impaired glucose tolerance similar to results seen among patients with T2DM (10).

Johny, et al., assessed the incidence of NODAT in kidney transplant recipients in Kuwait, as well as examining the role of immunosuppression and other risk factors

in the incidence and progression of NODAT. In the cohort of 631 kidney transplant recipients, 21.2% developed NODAT. Researchers documented that 19.7% of recipients who were diagnosed with NODAT were able to manage their blood glucose concentrations without the use of insulin or oral diabetic agents by modifying their diet, losing weight and being physically active. The remainder of kidney transplant recipients who developed NODAT required insulin or an oral diabetic agent to manage their diabetes. Johny, et al., concluded that lifestyle modification, including nutrition education, physical activity and weight maintenance counseling for kidney transplant recipients with abnormal glucose metabolism may assist in managing NODAT (10).

While there is minimal research on the effect of nutrition education for NODAT, the existing research provides promising results of improved glycemic control (10, 11). More research is needed to support the efficacy of nutrition education for the management of NODAT. Due to the multifaceted nature of NODAT, a specific nutrition education curriculum is warranted to educate patients on factors that contribute to NODAT and the effect of uncontrolled serum glucose concentrations on graft survival. These results suggest that lifestyle interventions, including nutrition education, could aid in weight management in patients who are overweight and obese and reduce the risk of developing NODAT (33, 34).

S.M.A.R.T. Goals

Specific, measurable, attainable, realistic, and time-sensitive (S.M.A.R.T.) goals are based on the human motivation research of Locke in the late 1960's. Locke determined that specific, attainable and difficult goals that incorporate feedback assists individuals in meeting goals (40). Locke, et al., promoted five principles to improve goal setting: clarity, challenge, commitment, feedback, and task complexity (41). Bovend'Eerdt, et al., went on to create a practical guide to writing S.M.A.R.T. goals and goal attainment (42). In this practical guide, goals can be constructed in a clinical setting using four parts: the targeted goal, the support needed, the quantification of performance, and the time for achievement (42). There is currently no research on the effect of S.M.A.R.T. goals with nutrition education on patient outcomes. This study will create the foundation of evidence for the efficacy of S.M.A.R.T. goals in a weight management and glycemic control after kidney transplant.

Conclusion

NODAT is a complex, multifaceted disease. Multiple risk factors play a role in the development and progression of NODAT, including age, ethnicity, obesity, immunosuppressive medications, and corticosteroids. Obesity is a confounding factor in kidney transplantation. Some research suggests that obese recipients tend to have longer hospital stays and increased complications, as well as increased patient mortality or graft failure (7, 8). Other research concludes that obese recipients have

similar patient and graft survival to that of non-obese kidney transplant recipients, and that transplantation should not be contraindicated (9).

Nutrition education has been shown to improve glycemic control and weight management in patients with T2DM (12, 36, 37). There have been few studies of the effect of nutrition education on glycemic control in patients who have NODAT. The studies that have examined the effect of nutrition education on NODAT have observed improved glycemic control. Further research is warranted to explore the effect of nutrition education on glycemic control and weight management in post-kidney transplant patients who develop NODAT and/or who gain weight after transplantation.

Chapter 3

Methods

General Design

An intervention study design was used to determine the effect of nutrition education on the intensity of diabetes mellitus (DM) treatment regimen and maintenance of body weight in kidney transplant recipients. DM treatment regimen was categorized into four groups: diet modification only, use of oral diabetic medications, use of insulin, or any combination of interventions. Treatment regimen combinations included: diet modification and use of oral diabetic medications, diet modification and use of insulin, and diet modification, use of oral diabetic medications, and use of insulin.

Participants in the intervention group were screened before their 2-week post-transplant clinic visit. Those who met inclusion criteria were seen initially at a routine out-patient clinic visit two weeks after transplantation. At that time, eligible participants provided written consent, data was collected from the electronic medical record (EMR), body weight was measured, nutrition education was provided, and each participant established a S.M.A.R.T goal. Participants were evaluated 6- and 12-weeks after transplantation. At follow-up appointments the participant was weighed, and other data was collected, nutrition education handout(s) provided at the initial visit were reviewed, and attainment of the S.M.A.R.T. goal was assessed.

Outcome data for any participant missed at 6- and 12 -week follow-up appointments was collected from the EMR. Nutrition education and follow-up on the

S.M.A.R.T. goals were completed at the next regularly scheduled post-transplant appointment.

Participants and Settings

This study included men and women, 18 years of age and older, who received a kidney transplant at Oregon Health & Science University Hospital and Clinics (OHSU) between October 1, 2014 and January 1, 2015. The study sample consisted of kidney transplant recipients who were discharged with newly prescribed insulin or oral diabetic agents or who were diagnosed with T2DM prior to transplantation. Participants also qualified for the study if they had gained at least 2 kg of body weight between hospital admission for kidney transplantation and a 2- week post-operative clinic visit. Kidney transplant recipients who were younger than 18 years of age, who did not speak English, who had cognitive limitations that would interfere with participation in the study, who received simultaneous transplantation of another organ, who had received a nephrectomy at the time of transplant, or who were immunosuppressed for non-transplant reasons were excluded. Inclusion and exclusion criteria are summarized in Table 1.

Table 1: Inclusion and Exclusion Criteria

Inclusion
 	
Criteria
	• Ability to speak and read in English
	• ≥ 18 years of age
	• Received a transplant after October 1, 2014 at Oregon Health & Science University (OHSU) Hospital and Clinics who have:
	  o Newly prescribed insulin or oral diabetic agent at discharge; or
	  o A 2 kg weight gain from hospital admission to 2 weeks post-transplant
	• Ability to understand and the willingness to sign a written informed consent form

Exclusion Criteria	• Simultaneous transplant of another organ at time of kidney transplant • Nephrectomy at time of transplant • Type 1 Diabetes Mellitus • Prescribed immunosuppression agents for non-transplant reasons • <18 years of age • Non-English speaking • Cognitive limitations that would prevent participation in education session

To identify a matched non-intervention control group, medical records of 240 adults who underwent kidney transplant at OHSU prior to May 1, 2014 were reviewed. Of the 240 patient records that were reviewed, 14 patients matched the participant baseline criteria. Criteria included age at transplant, sex, race, hepatitis C status, donor type, pre-transplant BMI, DM type, immunosuppression regimen, etiology of ESRD, and estimated glomerular filtration rate (eGFR). All data was obtained from the EMR.

Screening

Participants were screened by study staff after their kidney transplant and before routine 2-week post-transplant clinic visit. A HIPPA waiver for this initial screening phase was approved by the OHSU IRB. Screening data, gathered from the OHSU EMR, included previous diagnosis of T2DM, newly prescribed insulin, and/or oral diabetic agents. Additionally, participants were screened at the two week follow-up appointment for a minimum 2 kg increase in weight since their hospital admission for kidney transplantation.

Data Collection

Baseline data, at the time of hospital admission and 2-weeks post-transplant, was collected from EMR and included the date of hospital admission for transplant surgery, age, sex, race/ethnicity, weight, height, etiology of ESRD, type of kidney donation, components of DM treatment regimen (diet, oral diabetic medications,

insulin, or a combination of interventions), plasma creatinine concentration, eGFR, types of induction and maintenance immunosuppressant medication, and hepatitis C status. Outcome data was collected 6- and 12-weeks after kidney transplantation and included weight, maintenance immunosuppressant therapy, components and dosage of DM treatment regimen, new diagnosis of NODAT, plasma creatinine concentration, eGFR, post-transplant dialysis status (Y/N), duration of hospital admission (days), and delayed graft function (defined as dialysis required during the transplant admission). A data collection worksheet is provided in Appendix A.

Nutrition Education Protocol

Participants who received a new prescription for insulin and/or oral diabetic agents at hospital discharge received the glycemic control handout. Those who gained more than 2 kg since hospital admission received the weight maintenance handout. Participants who had received a new prescription for insulin and/or oral diabetic agents and who had gained weight will receive both handouts. Study staff recorded which handout(s) were used for patient education. Nutrition education handouts were given at the two-week post-transplant follow-up appointment.

Participant-centered education began with open-ended questions about the participant's current diet, which was utilized by the study staff to clinically judge the participant' usual foods and beverage intake as well as timing of meals and the number of meals in a day. Next, study staff utilized the handout to guide conversation about potential changes in post-transplant glycemic control and/or post-transplant changes in weight. The participant was educated on the plate method and

counseled on how that method could be incorporated into the participants' current diet. Lastly, a S.M.A.R.T goal, that was lifestyle related, was established by the participant. This goal was recorded by study staff. At post-transplant week 6 and 12, nutrition counseling was utilized to assess the implementation of the plate method, as well as, a review of the nutrition education handout. Lastly, whether a participant achieved his/her S.M.A.R.T. goal was recorded.

Both handouts were based on The Plate Method from the American Diabetes Association, which advises making ½ of the meal plate non-starchy vegetables, ¼ of the meal plate grains or starchy vegetables, ¼ of the meal plate protein, and having ½ cup of fruit and 1 cup of skim or 1% milk or light yogurt with meals. This is illustrated in Appendix B and Appendix C. The glycemic control handout assisted in educating participants about consistent carbohydrate intake, as well as the causes of high blood sugar and the risks of chronically high blood sugar (43). The weight management handout assisted in education of portion sizes and energy intake, as well as common causes of weight gain after transplant (43).

Anthropometric Measurements

Weight was measured in light clothing using a stand-on scale with digital display (Scale-Tronix Model 5004, Wheaton IL) to the nearest 0.01 kg at time of admission for transplant and in the post-transplant clinic by the OHSU nursing staff. Height was measured without shoes with a wall-mounted stadiometer (Harpenden Stadiometer, Holtain Ltd, Crymych, UK) and recorded to the nearest 0.01 cm. BMI

was calculated as weight in kilograms, divided by height in meters-squared. The measures were obtained as part of routine clinical care and this information was obtained from the EMR.

Blood Sample Collection and Analysis

Blood samples were collected from a peripheral arm vein by venipuncture using sterile technique. Blood samples were collected into 10 mL heparinized tubes and sent to the OHSU Clinical Chemistry Laboratory for analysis of plasma creatinine concentration using the Jaffe's method (44). The measures were obtained as part of routine clinical care and this information was obtained from the EMR.

Calculations

eGFR appears on routine laboratory reports. At OHSU, it is calculated with the Modification of Diet in Renal Disease (MDRD) eGFR equation, which takes into account plasma creatinine concentration, age, race, and gender (45). The MDRD eGFR equation is (mL/min/1.73 m^2) = 175 × (serum creatinine)$^{-1.154}$ × (Age)$^{-0.203}$ × (0.742 if female) × (1.212 if African American) (45).

Data Management

Data was de-identified and recorded in an electronic Microsoft Excel database. Data within the Microsoft Excel database was exported to STATA for

statistical analysis. All endpoint data were verified by visually comparing database contents with source forms. Data was maintained electronically on an OHSU hard drive in a computer in Gaines Hall room 212.

Confidentiality

All participant information was considered confidential. Confidentiality was assured through several mechanisms. First, each participant was assigned a unique study identifier which was used on all study forms. Second, all study forms, and paper records that contain participant information were kept in a secured, locked storage cabinet in Gaines Hall Room 212. In addition, such materials, when in use, were kept away from public scrutiny. Third, access to all participant data and information, including laboratory specimen results, was restricted to authorized study personnel. In the case of computerized information, access to the study data on computers was password protected. Study personnel signed a confidentiality statement affirming that they agreed to abide by the OHSU's policies on research confidentiality and ethics. Finally, patients were not identified by name in any reports nor was data presented in such a way that the identity of individual participants could be inferred.

Statistical Analysis

STATA, Version 11.0 (StataCorp, College Station, TX.), was used to analyze the data. Prism was used to create figures. Microsoft Word was used to create tables.

The sample was summarized using means, standard deviations, and standard error for continuous characteristics and frequencies and percentages for categorical variables. Propensity score matching was used to identify participants in the control and intervention group having comparable age at transplant, sex, race, hepatitis C status, donor type, pre-transplant BMI, immunosuppressant medication regimen, etiology of ESRD, and eGFR. The propensity score is the probability of treatment assignment based on baseline characteristics, which mimics the characteristics of a randomized controlled trial (46). Significance of mean differences in change in weight between the control and intervention groups from hospital admission to 6 weeks post-transplant and 6 weeks to 12 weeks post-transplant was quantified by t-tests. Descriptive statistics described change in insulin use and/or oral diabetic agents at the time of discharge, at 6 weeks, and 12 weeks after transplant. Diabetes treatment regimen was categorized as a binary variable.

Change in glycemic control was described as no change if a participant had the same diabetes treatment regimen between discharge to 6 weeks or 6 weeks to 12 weeks post-transplant. It was considered worsened when a participant was prescribed new or additional units of insulin and/or a new oral diabetic agent and/or an increase in dosage of oral diabetic agent between discharge to 6 weeks or 6 weeks to 12 weeks post-transplant. It was defined as improved when a participant was prescribed the discontinuation of or fewer units of insulin and/or the discontinuation of or a decrease in dosage of oral diabetic agent between discharge to week 6 or 6 weeks to 12 weeks post-transplant. Education handouts were categorized as glycemic control, weight management, or both. Patient age (continuous variable), gender (binary variable),

immunosuppressant regimen (categorical variable with one levels), and etiology of ESRD (categorical variable with four levels) were included in the model as independent variables. Level of significance was set at 5% (0.05) and effects due to intervention (relative to control) estimated by 95% confidence intervals.

Chapter 4

Results

General

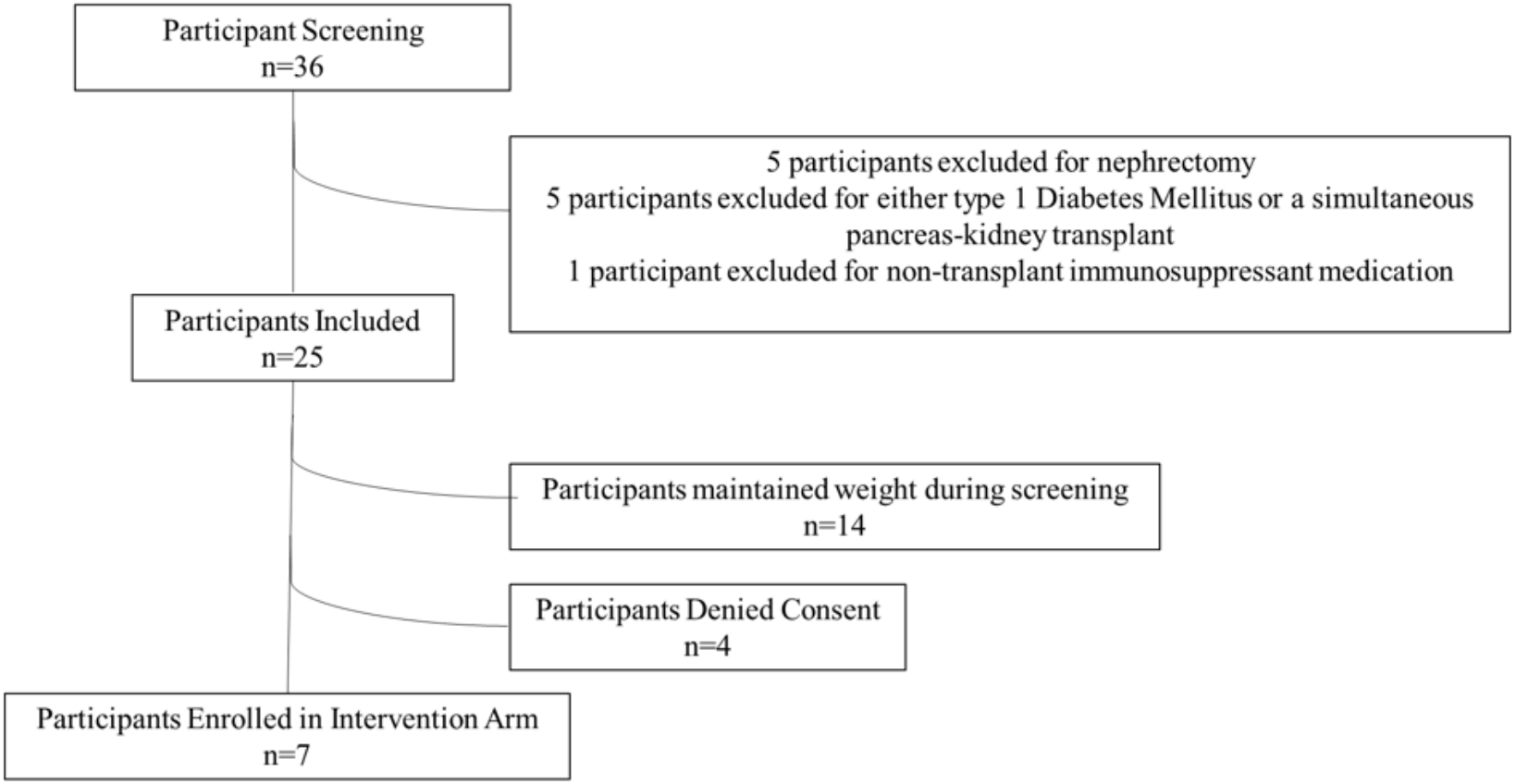
An intervention study design was used to determine the effect of nutrition education on the intensity of diabetes treatment regimen and maintenance of body weight in kidney transplant recipients. We hypothesized that kidney transplant recipients with type 2 diabetes mellitus, who develop new onset diabetes after transplantation, or who gain weight within two weeks of transplantation and who receive nutrition education on weight management and/or glycemic control, will maintain or lose weight and/or maintain or improve their diabetes treatment regimen compared to a matched controls who do not receive post-transplant nutrition education.

The results of the electronic medical record (EMR) query to identify and enroll eligible patients are illustrated in Figure 1. Of the 36 potential participants who were screened for the intervention arm of the study, 11 were excluded due to exclusion criteria, including undergoing a nephrectomy at time of transplant, being diagnosed with type 1 diabetes mellitus or a simultaneous pancreas-kidney transplant, or being on immunosuppressant medications for non-transplant reasons. Fourteen participants were excluded because they maintained their weight between hospital admission and 2 weeks after discharge and 4 denied consent. Seven potential participants met the inclusion criteria and were enrolled. Of the 7 participants who

enrolled in the intervention arm of the study, 4 had T2DM prior to transplantation and 1 developed NODAT.

Of the 240 medical records that were reviewed to identify historical control participants, 14 kidney transplant recipients were matched to the participants in the intervention group by using a propensity score procedure as explained in the Methods section. Intervention participants received their kidney transplant between October 2014 and January 2015. Control participants received their kidney transplant between April 2011 and May 2014. All participants received their kidney transplant at OHSU. The characteristics of the control and intervention groups are illustrated in Table 2.

Figure 1: Results of Screening Process to Enroll Kidney transplant Patients into the Intervention Arm of the Study



Pre-transplant characteristics of the intervention and control participants, including age, pre-transplant BMI, sex, race and ethnicity, serum creatinine concentration, GFR, hepatitis C status, donor type, whether the patient had T2DM prior to transplant, and the etiology of ESRD, are described in Table 2. The average age of the intervention and control groups was 56 ± 15 years and 53 ± 15 years, respectively. The intervention group consisted of 5 males and 2 females. It also included 6 individuals who were white, 1 individual who was Asian, and 1 individual who was Hispanic. The control group consisted of 10 males and 4 females. It included 12 individuals who were white, 2 individuals who were Asian, and with no individuals who were Hispanic. The pre-transplant average BMI of the control and intervention groups was 25.1 ± 3.5 kg/m^2 and 27.5 ± 3.5 kg/m^2, respectfully. There were no significant differences in means or frequencies of the characteristics reported between intervention and control groups, suggesting that the propensity score matching process was successful.

Table 2: Pre-Transplant Characteristics of Participants in the Intervention and Control Groups

Characteristic	Intervention n=7	Control n=14
Age (years)*	56 ± 15	53 ± 15
Sex		
Male, n (%)	5 (71%)	10 (71%)
Female, n (%)	2 (29%)	4 (29%)
Race White, n (%)	6 (86%)	12 (86%)
Ethnicity		
Hispanic, n (%)	1 (14%)	0 (0%)
Non-Hispanic, n (%)	6 (86%)	14 (100%)
BMI (kg/m^2)*	27.5 ± 3.5	25.13 ± 3.5
Serum Creatinine (mg/dL)*	7.41 ± 2.87	7.48 ± 1.66
GFR (mL/min/1.73 m^2)*	8.14 ± 3.98	8.79 ± 2.97
Hepatitis C Positive, n (%)	0 (0%)	0 (0%)
Donor Type		
Deceased, n (%)	6 (86%)	12 (86%)
Living, n (%)	1 (14%)	2 (14%)
T2DM	4 (57%)	4 (29%)
Etiology of ESRD		
Hypertension, n (%)	2 (29%)	4 (36%)≈
Diabetes Mellitus, n (%)	2 (29%)	4 (29%)≈
Other, n (%)	3 (43%)	6 (43%)

Glycemic Control

Glycemic control for intervention participants who had T2DM prior to transplantation and the participant who developed NODAT is summarized in Table 3. Of the seven participants enrolled in the intervention arm of the study, four had T2DM prior to transplantation, and one developed NODAT. From hospital admission to discharge, two intervention participants with T2DM had a worsening of diabetes treatment regimen and two had no change in their diabetes treatment regimen. From hospital discharge to post-transplant week 6, three participants had a worsening and one participant had an improvement of diabetes treatment regimen. From week 6 to week 12, two participants had an improvement and two had no change in their diabetes treatment regimen. The participant who developed NODAT required a diabetes treatment regimen after the transplant procedure to hospital discharge. From hospital discharge to week 6, the participant had a worsening of diabetes treatment regimen; from week 6 to week 12 post-transplant, had no change in diabetes treatment regimen.

Table 3: Changes in Diabetes Treatment Regimen in Intervention Participants

Diabetes Type	Intervention Participants (n=7)	Hospital Admission to Discharge	Hospital Discharge to Week 6	Week 6 to Week 12
T2DM	1	Worsen	Worsen	No Change
	2	Worsen	Improve	No Change
	3	No change	Worsen	Improve
	4	No change	Worsen	Improve
NODAT	5	Worsen	Worsen	No Change

T2DM = Type 2 Diabetes Mellitus
NODAT = New Onset Diabetes After Transplant
No change = Participant had the same diabetes treatment regimen as previously prescribed
Worsened = Participant was prescribed new or additional units of insulin and/or a new oral diabetic agent and/or an increase in dosage of oral diabetic agent
Improved = Participant was prescribed the discontinuation of or less units of insulin and/or the discontinuation of an oral diabetic agent or a decrease in dosage of oral diabetic agent

Changes in glycemic control for control participants with T2DM prior to transplantation or NODAT are illustrated in Table 4. Of the fourteen participants in the control group, four had T2DM prior to transplantation and two developed NODAT. Three participants with T2DM had no change and one participant had a worsening of their diabetes treatment regimen from hospital admission to discharge. From hospital discharge to week 6, three participants had a worsening and one participant had an improvement of their diabetes treatment regimen. From week 6 to week 12, two participants had no change and two had worsening of their diabetes treatment regimen. Both of the participants who were diagnosed with NODAT had a worsening of their diabetes treatment regimen from hospital discharge to week 6. From week 6 to week 12 post-transplant, one participant had an improvement and the other had a worsening of their diabetes treatment regimen.

Table 4: Changes in Diabetes Treatment Regimen in Control Participants

Diabetes Type	Control Participants (n=14)	Hospital Admission to Discharge	Hospital Discharge to Week 6	Week 6 to Week 12
T2DM	1	No Change	Worsen	No Change
	2	No Change	Worsen	Worsen
	3	No Change	Improve	No Change
	4	Worsen	Worsen	Worsen
NODAT	5	N/A	Worsen	Improve
	6	N/A	Worsen	Worsen

N/A = Participant was not prescribed a diabetic diet, insulin, or an oral diabetic agent
T2DM = Type 2 Diabetes Mellitus
NODAT = New Onset Diabetes After Transplant
No change = Participant had the same diabetes treatment regimen as previously prescribed
Worsened = Participant was prescribed new or additional units of insulin and/or a new oral diabetic agent and/or an increase in dosage of oral diabetic agent
Improved = Participant was prescribed the discontinuation of or less units of insulin and/or the discontinuation of an oral diabetic agent or a decrease in dosage of oral diabetic agent

Weight Management

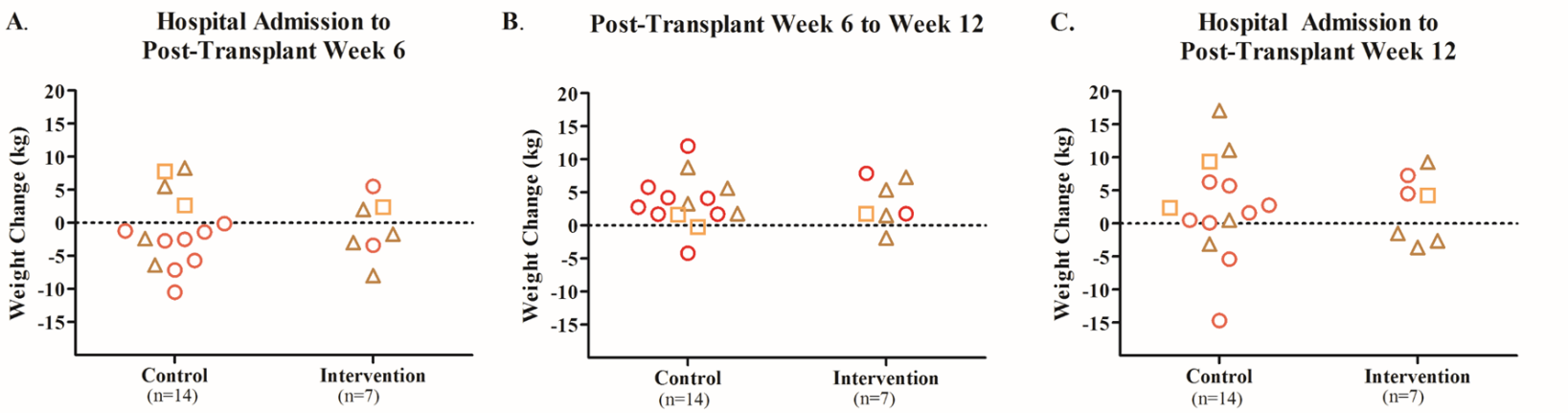
The individual weight changes of both intervention and control participants between hospital admission and post-transplant week 6 are illustrated in Figure 2A; individual weight changes between post-transplant week 6 and week 12 are illustrated in Figure 2B; individual weight change between hospital admission and post-transplant week 12 is illustrated in Figure 2C. A comparison of mean weight of the intervention and control groups at hospital admission and post-transplant week 6 and week 12 is illustrated in Figure 3. The individual weights for control participants is illustrated in Figure 4A; the individual weights for intervention participants are illustrated in Figure 4B.

On average, between admission and post-transplant week 6, the control group lost 0.24 kg (standard error 2.4) more than the intervention group, though this difference was not significant (p=0.92). From post-transplant week 6 and week 12, the control group gained 0.18 kg (standard error 1.7) more than the intervention group, though this difference was not statistically significant (p=0.92). The mean weight for both intervention and control groups follows the same trajectory.

Within the intervention group, participants lost an average of 0.89 ± 4.5 kg between hospital admission to post-transplant week 6, which was not significant (p= 0.66). Between post-transplant week 6 and 12, intervention participants gained an average of 3.4 ± 3.6 kg, which was significant (p= 0.03). Within the control group, participants lost an average of 1.1 ± 5.6 kg from hospital admission to post-transplant week 6, which was not significant (p= 0.43). Between post-transplant week 6 and 12, control participants gained an average of 3.6 ± 3.9 kg, which was not significant (p=

0.002). Between hospital admission and week 12 after transplant, the intervention group gained an average of 2.5 ± 5.1, which was not significant (p=0.35) and the control group gained an average of 2.4 ± 7.7 kg, which was not significant (p=0.20). The change in weight over the duration of 12 weeks was not significant within either group.

Figure 2: Change in Weight of Intervention and Control Participants from Hospital Admission to Week 6, From Week 6 to Week 12, and From Hospital Admission to Week 12



○ =Non-Diabetic Subjects
△ =Subjects with Type 2 Diabetes Mellitus (T2DM)
□ =Subjects with New Onset Diabetes After Transplant (NODAT)

Figure 3:

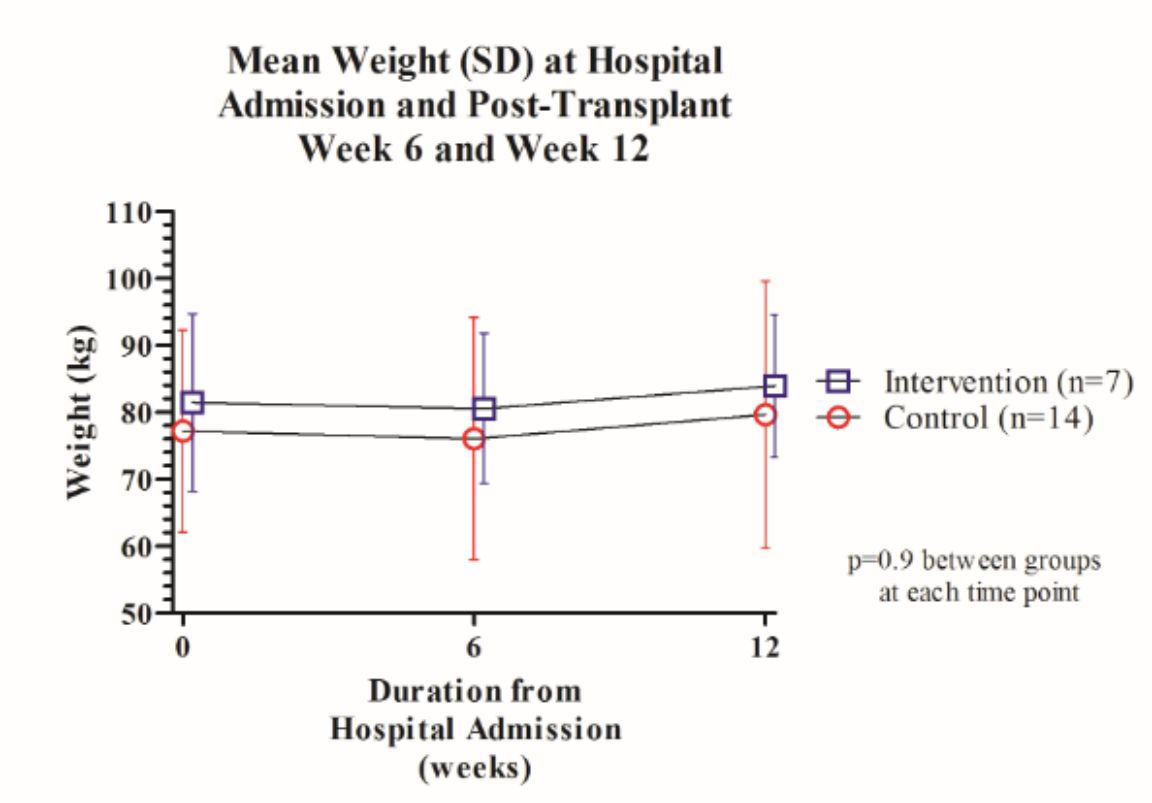
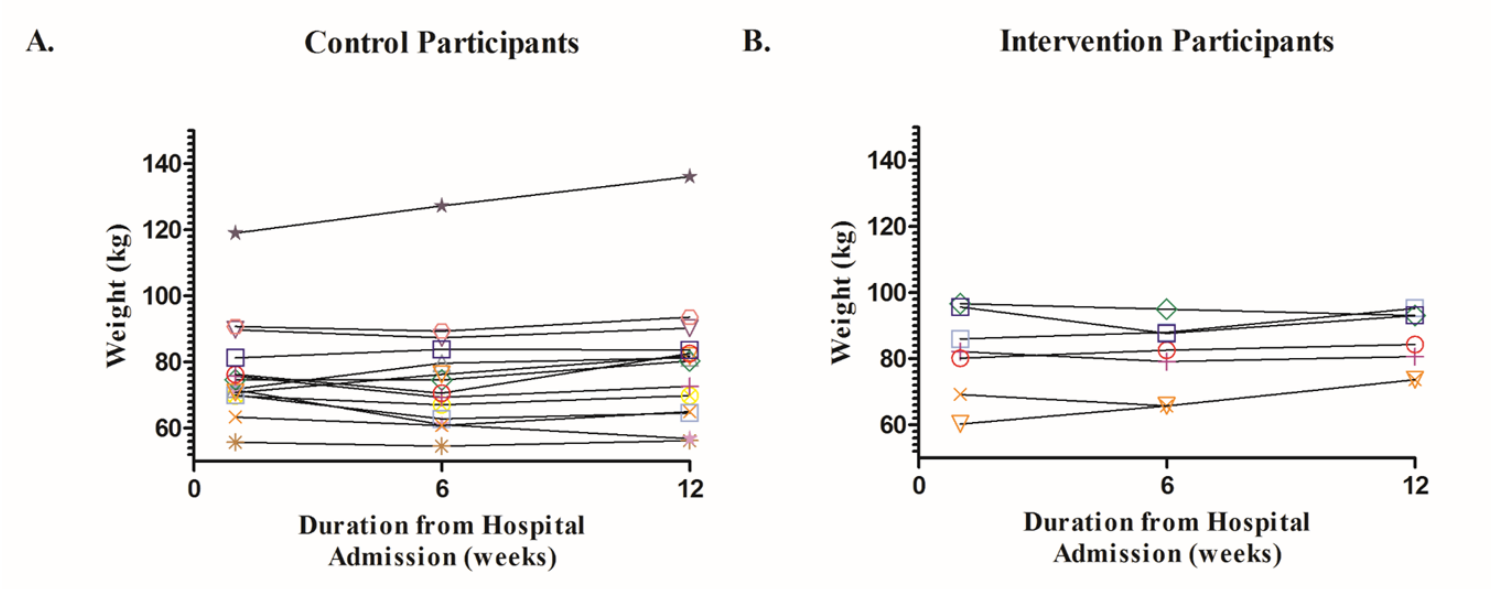

Mean Weight (SD) at Hospital Admission and Post-Transplant Week 6 and Week 12
Weight (kg)
110
100
90
80
70
60
50
0
6
12
Duration from Hospital Admission (weeks)
Intervention (n=7)
Control (n=14)
p=0.9 between groups at each time point

Figure 4: Weight of Control and Intervention Participants at Hospital Admission and Post-Transplant Week 6 and Week 12



S.M.A.R.T. Goals

S.M.A.R.T. goals were generated by participants in the intervention group as part of the nutrition education procedure. Table 5 lists each patient's goal and whether that goal was met or not met. At post-transplant week 6 and week 12, 4 (57%) intervention participants met their S.M.A.R.T. goal. The relationship between change in weight and achievement of S.M.A.R.T. goal is illustrated in Table 6. Those who met their goal at post-transplant week 6, lost an average of 0.8 ± 6.0 kg between hospital admission and post-transplant week 6, compared to those who did not meet their S.M.A.R.T. goal, 1.0 ± 1.6 kg. Those who met their goal at week 12, gained an average of 2.2 ± 1.8 kg between week 6 and week 12, compared to those who did not meet their S.M.A.R.T. goal, 5.0 ± 2.0 kg.

The results of change in glycemic control and whether a participant met or did not meet their S.M.A.R.T. goal are illustrated in Table 7. Four participants were diagnosed with T2DM prior to transplant, at post-transplant week 6, two met their S.M.A.R.T. goal and two had a worsening of diabetes treatment regimen. At post-transplant week 12, three of the four participants met their S.M.A.R.T. goal of whom two had an improvement of their diabetes treatment regimen, while the other two participants had no change in their diabetes treatment regimen. The one participant who was diagnosed with NODAT met his/her S.M.A.R.T. goal but had a worsening of diabetes treatment regimen at week 6. At week 12, this same participant had no change in his/her diabetes treatment regimen and met his/her S.M.A.R.T. goal.

Table 5: Participant Selected S.M.A.R.T. Goals and Status of Goal Achievement at Post-Transplant Week 6 and 12

S.M.A.R.T. Goal	6 Weeks	12 weeks
"Walk one mile three times a week."	Not Met	Not Met
"Drinking two liters of water a day by using a reusable water bottle, adding lemon to water, and using water flavoring."	Met	Met
"Walk around my neighborhood for 15-20 minutes per day."	Met	Not Met
"Eat a consistent amount of carbohydrates throughout the day by measuring out portion sizes."	Met	Met
"Walk for a total of one hours a day by breaking it down into 15 minute increments throughout the day."	Met	Not Met
"Add a protein component, such as nut butter, cheese, yogurt, to every meal and snack."	Not Met	Met
"Use a stationary bike for 15 minutes a day and walk for 15 minutes a day."	Not Met	Met

Table 6: Weight at Intervention Participants at Hospital Admission and Post-Transplant Week 6 and Week 12 and Achievement of S.M.A.R.T. Goals

Participant	Hospital Admission Weight (kg)	Week 6 Weight (kg)	Week 12 Weight (kg)
1	69.2	65.8	73.7
2	80.2	82.6*	84.4*
3	95.7	87.7*	93.1
4	82.2	79.2*	80.7*
5	60.3	65.8*	67.6
6	86.0	88.0	95.3*
7	96.7	95.0	93.1*

* S.M.A.R.T. Goal Met

Table 7: Changes in Glycemic Control From Hospital Admission to Discharge, Discharge to Week 6, and Week 6 to Week 12 and Achievement of S.M.A.R.T. Goal

Diabetes Type	Intervention Participants (n=7)	Hospital Admission to Discharge	Hospital Discharge to Week 6	Week 6 to Week 12
T2DM	1	Worsen	Worsen*	No Change*
	2	Worsen	Improve*	No Change
	3	No change	Worsen	Improve*
	4	No change	Worsen	Improve*
NODAT	5	Worsen	Worsen*	No Change*

T2DM = Type 2 Diabetes Mellitus
NODAT = New Onset Diabetes After Transplant
No change = The participant had the same diabetes treatment regimen as previously prescribed
Worsened = The participant was prescribed new or additional units of insulin and/or a new oral diabetic agent and/or an increase in dosage of oral diabetic agent
Improved = The participant was prescribed the discontinuation of or less units of insulin and/or the discontinuation of an oral diabetic agent or a decrease in dosage of oral diabetic agent
* S.M.A.R.T. Goal Met

Conclusion

In general, kidney transplant recipients initially lost weight, although the mean change in weight was not statistically significant, between hospital admission to post-transplant week 6 in either group. They later tended to gain weight between post-transplant week 6 to week 12, which was statistically significant within both groups. Kidney transplant recipients with T2DM who received nutrition education were divided between those who experienced no change and those whose diabetes treatment regimen worsened from hospital admission to discharge. The majority of those who received nutrition education experienced a worsening of diabetes treatment regimen from hospital discharge to post-transplant week 6 and were split between no change or an improvement in diabetes treatment regimen at post-transplant week 12. The one recipient in the intervention group who developed NODAT had a worsening of diabetes treatment regimen from hospital admission to discharge and from hospital discharge to post-transplant week 6. However, from post-transplant week 6 to week 12, that same participant had no change in diabetes treatment regimen.

We hypothesized that kidney transplant recipients who had T2DM prior to transplant or those who developed NODAT, and who received nutrition education on glycemic control would maintain or improve their diabetes treatment regimen compared to controls. This hypothesis is accepted due to suspected improvement in transplant recipients' diabetes treatment regimens by post-transplant week 12 compared to controls.

Additionally, we hypothesized that kidney transplant recipients who gained weight within two weeks of transplantation, and who received nutrition education on

weight management would maintain or lose more weight than controls. This hypothesis is rejected as both groups gained a similar amount of weight between hospital admission and post-transplant week 12.

Chapter 5

Discussion

Summary

The results of this study were derived from data obtained from 7 participants who received a kidney transplant at Oregon Health & Science University (OHSU) between October 2014 and January 2015 and compared to patient information extracted from electronic medical records (EMR) of 14 historical participants who received a kidney transplant at OHSU between April 2011 and May 2014. Our goal was to determine the impact of providing nutrition education about glycemic control on the diabetes treatment regimen of individuals with pre-existing type 2 diabetes mellitus (T2DM) or new onset diabetes after transplant (NODAT) and/or the impact of nutrition education about weight management on patients' weight during 12 weeks after transplant.

There are three important conclusions of this study. First, regardless of whether nutrition education was received, the mean change in weight from hospital admission to 6 weeks post-transplant and then from 6 weeks to 12 weeks post-transplant was not significantly different between the intervention and control groups. Second, there was a suggested improvement in diabetes treatment regimen at post-transplant week 12 among participants who received nutrition education on glycemic control. Third, the use of S.M.A.R.T. goals in conjunction with nutrition education did not significantly affect weight maintenance or glycemic control after transplant.

These findings are important and set the stage for future research because, despite the success of kidney transplantation, complications, such as NODAT or the worsening of pre-existing T2DM, still occur and appear to contribute to increased mortality and increased incidence of cardiovascular disease post-transplant (47, 48). An early post-transplant intervention, such as nutrition education, can potentially assist transplant recipients in maintaining blood glucose levels, which could possibly reduce the risk of cardiovascular events and infection related post-transplant death. In a study conducted at OHSU and published in 2006, de Mattos, et al., identified obesity ($p < 0.001$), diabetes ($p < 0.001$), and overweight status ($p = 0.04$), as risk factors that contributed to cardiovascular events following kidney transplant (48). In 2007, Joss, et al., reported that the ten-year patient survival rate was lower in patients who had pre-existing diabetes (65.3%) or who developed NODAT (67.1%) compared to patients without diabetes (81.9%).

New-Onset Diabetes After Transplant

Several factors contribute to the risk of NODAT, including Hispanic ethnicity, age > 40 years, family history of diabetes mellitus, a body mass index greater than 35 kg/m^2, being the recipient of a deceased donor kidney, and post-transplant weight gain (6, 7, 20-23, 25, 26). One of seven intervention participants developed NODAT, and had the risk factors of age > 40 years, a family history of DM, and being the recipient of a deceased donor kidney. This individual's diabetes treatment regimen worsened from hospital discharge to post-transplant week 6, despite the nutrition education intervention and medical nutrition therapy provided at the diabetes

treatment center. The worsening of diabetes treatment regimen from hospital discharge to week 6 after transplant could be attributed, in part, to the side effects of two immunosuppressant medications, prednisone and tacrolimus, as well as the participants' anxiety about diet changes and reduced physical activity. From week 6 to week 12, the participant who developed NODAT had no change in diabetes treatment regimen. The stabilization of diabetes treatment regimen from week 6 to week 12 could potentially be attributed to a decreased dosage of immunosuppressant medications, as well as the nutrition education and counseling given in the intervention and the coordination of care from the diabetes treatment center.

In 2008, the effect of lifestyle modification on NODAT reported by Sharif, et al., noted that of the seven participants diagnosed with NODAT and who received a lifestyle modification invention, two were able to obtain normal serum glucose concentrations, two met the criteria for impaired serum glucose tolerance, but did not meet the criteria for NODAT, and the remaining three participants continued to have a diagnosis of NODAT. (10). Johny, et al., found that 19.7% of transplant recipients with NODAT were able to manage their blood glucose concentrations without the use of insulin or oral diabetic agents by modifying their diet, losing weight, and being physically active (11). The findings in our study are limited by an extremely small sample size and short duration; the results reported here, in addition to previous research, support the importance of providing nutrition education about glycemic control for kidney transplant recipients who develop NODAT.

Type 2 Diabetes Mellitus Glycemic Control

The majority of intervention participants who were diagnosed with T2DM prior to transplant had a worsening of diabetes treatment regimen between hospital discharge and week 6 after transplant. This could be explained, in part, by side effects of two immunosuppressant medications, prednisone and tacrolimus. By week 12, two of the four intervention group with T2DM had an improvement and the other two had no change of diabetes treatment regimen. Contributing factors to improved or no change in diabetes treatment regimen include a lower maintenance corticosteroid dosage than immediately after transplant, nutrition education received in this intervention, and/or additional nutrition education received at the diabetes treatment center.

In 2013, Adachi, et al., examined the effect of lifestyle intervention by a RDN for T2DM and observed a statistically significant improvement, -0.7%, in hemoglobin A1C values but did not observe a statistically significant change in weight or BMI (37). In 2014, Yuan, et al., assessed the effect of diabetes self-management education on metabolic markers and atherosclerotic parameters in patients who were diagnosed with T2DM and found that individuals who completed the diabetes self-management education series, with standard medical nutritional therapy, achieved a 0.2% ± 0.6% reduction in hemoglobin A1C serum levels and a 1.19 kg ± 1.39 kg reduction in body weight, compared to control participants, who received only standard medical nutrition therapy, obtained a 0.08% ± 0.74% reduction in hemoglobin A1C serum levels and a 0.61 kg ± 2.04 kg reduction in body weight (12).

Although hemoglobin A1C is traditionally assessed in T2DM literature, it was implausible in this study for two reasons: hemoglobin A1C is used as a long term marker of blood glucose management and would not be reflective of glycemic control in the short duration of this study and hemoglobin A1C is not routinely ordered for transplant recipients. Despite this difference in the literature, the results seen in this study, as well as previous research, support the use of nutrition education about glycemic control among those who have T2DM (12, 37).

Weight Maintenance

Intervention and control participants followed the same weight trajectory over the twelve week study period. This pattern, a slight weight loss from hospital admission to six weeks after transplant and then weight gain from week six to week 12, has not been previously described in transplant literature. This pattern may be an artifact of the small sample size, corticosteroid and immunosuppressant dosage, reduced physical activity, and/or stress associated with the transplant process. Transplant recipients have multiple stressors: post-surgical pain, intense medication management, several clinic appointments per week, multiple blood draws per week, and the emotional, social, and logistical impact of changing from dialysis therapy to post-transplant status. Lopes, et al., investigated the use a weight loss diet among kidney transplant recipients and observed a mean weight loss of 3.2 ± 2.9 kg within 6 months (35). Due to the controversial nature of obesity in the kidney transplant population, the research on weight maintenance and/or loss in transplant recipients is

minimal. The results of this study do not demonstrate the modest weight loss other researchers have observed in the non-transplant population (33, 34).

This study design utilized weight taken at hospital admission versus discharge weight to minimize the confounding effect of changes in fluid balance in the immediate post-operative period. Potential research going forward should examine a larger sample size, a longer follow-up period, and/or the utilization of bioelectrical impedance (BIA), dual-energy X-ray absorptiometry (DXA), or other equipment to assess change in body composition in addition to change in weight. Overall, additional research is needed to further understand the long term trends in weight management and post-surgical outcomes of transplant recipients.

S.M.A.R.T. Goals

There is currently no literature to support the use of specific, measurable, attainable, realistic, and time-sensitive (S.M.A.R.T.) goals in the field of nutrition and dietetics. This study will begin to form the base of evidence for the use of S.M.A.R.T. goals in helping nutrition education become more successful. It was observed that participants with T2DM prior to transplantation had either no change or an improvement in their diabetes treatment regimen when they met their S.M.A.R.T. goal at week 12. This could be attributed to having the patient focus on a self-selected wellness goal that aided in physical activity or consistent carbohydrate intake, but could also be due to a reduction in immunosuppressant and corticosteroid dosage, among other factors. Participants who met their S.M.A.R.T. goal lost more

weight between hospital admission to week 6 and gained less weight between week 6 and week 12 compared to those who did not meet their S.M.A.R.T. goal. These results suggest that S.M.A.R.T. goals may aid in weight maintenance by helping patients focus on small specific changes, such as incorporating physical activity throughout the day or replacing empty calorie beverages with water. This pilot study suggests that S.M.A.R.T. goals may help patients achieve nutrition and physical activity goals, which may improve patient health. Despite these encouraging findings, additional research in a larger population is needed to support the use of S.M.A.R.T. goals in nutrition education.

Strengths

The strengths of this research study include the use of participant-centered nutrition education, an early intervention, and the utilization of S.M.A.R.T. goals to facilitate dietary changes. Additionally, an important aspect of this study is exploring previously unexplored areas of post-transplant care to enhance patient self-management. A major strength of this study was the use of a propensity score to identify a matched control group. The matching process of the propensity score included baseline characteristics, such as age at transplant, sex, race, hepatitis C status, donor type, pre-transplant BMI, immunosuppressant medication regimen, etiology of ESRD, and eGFR. This method allowed for two control participants to be matched to each intervention participant.

Limitations

The limitations of this research study include the small sample size that was not powered to detect significant differences between groups, a low intensity intervention, and a short time frame to observe an impact of nutrition education. One confounding factors of this study is possible additional nutrition education received by some post-transplant participants due to routine referrals for medical nutrition therapy at the Diabetes Clinic at OHSU. A second confounding factor is the inability to control for light clothing at hospital admission, discharge, and at clinic appointments for participant weight. There was an effort to address the small sample size by extending the timeframe of participant enrollment and by matching participants with one or more control participants using a propensity score model. Although, the participant enrollment timeframe was extended, the sample size was not large enough to detect significant differences in change in weight and/or glycemic control between groups.

Future Research

Our study suggests that nutrition education may lead to improved glycemic control in transplant recipients with T2DM or others who develop NODAT. Therefore, patients at risk for developing NODAT or patients with pre-existing DM should be monitored, evaluated for changes in dietary intake, insulin and/or oral diabetic agents by the multi-disciplinary transplant team, including registered dietitians nutritionists (RDNs). Although the results of this study were inconclusive,

the novel question of whether nutrition education impacts NODAT merits further study.

Conclusions

Based on the results reported here, we conclude that kidney transplant recipients follow the same weight trajectory, regardless of receiving nutrition education. The results of this study also suggest that nutrition education may improve or maintain a patient's diabetes treatment regimen post-transplant. We show that the first three months after kidney transplantation are particularly critical for both the development of NODAT and changes in DM status, but the results of this study should be interpreted cautiously due to small sample size.

References

1. Cullen T, McCarthy M, Lasarev M, Barry J, Stadler D. Body Mass Index and the Development of New-Onset Diabetes Mellitus or the Worsening of Pre-Existing Diabetes Mellitus in Adult Kidney Transplant Patients. Journal of Renal Nutrition 2014;24(2):116-22.

2. Anonymous Annual Report of the U.S. Organ Procurement and Transplantation Network and the Scientific Registry of Transplant Recipients. Version current 23 May 2014. Internet: http://optn.transplant.hrsa.gov/data/ (accessed 28 May 2014).

3. United States Renal Data System. USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2013. [2013

4. Kesiraju S, Paritala P, Rao Ch UM, Sahariah S. New onset of diabetes after transplantation — An overview of epidemiology, mechanism of development and diagnosis. Transpl Immunol 2014;30:52-8.

5. Demirci MS, Toz H, Ylmaz F, Ertilav M, Asci G, Ozkahya M, Zeytinoglu A, Nart D, Ok E. Risk factors and consequences of post-transplant diabetes mellitus. Clin Transplant 2010;24:E170-7.

6. Joss N, Staatz CE, Thomson AH, Jardine AG. Predictors of new onset diabetes after renal transplantation. Clin Transplant 2007;21:136-43.

7. Grosso G, Corona D, Mistretta A, Zerbo D, Sinagra N, Giaquinta A, Caglià P, Amodeo C, Leonardi A, Gula R, et al. The Role of Obesity in Kidney Transplantation Outcome. Transplant Proc 2012;44:1864-8.

8. Cacciola RAS, Pujar K, Ilham MA, Puliatti C, Asderakis A, Chavez R. Effect of Degree of Obesity on Renal Transplant Outcome. Transplant Proc 2008;40:3408-12.

9. Marks WH, Florence LS, Chapman PH, Precht AF, Perkinson DT. Morbid obesity is not a contraindication to kidney transplantation. The American Journal of Surgery 2004;187:635-8.

10. Sharif A, Moore R, Baboolal K. Influence of Lifestyle Modification in Renal Transplant Recipients with Postprandial Hyperglycemia. Transplantation 2008;85:3:353-8.

11. Johny KV, Nampoory MRN, Costandi JN, Gupta RK, Ninan VT, Samhan M, Muzairai I, Al-Mousawi M. High incidence of post-transplant diabetes mellitus in Kuwait. Diabetes Res Clin Pract 2002;55:123-30.

12. Yuan C, Lai C, Chan L, Chow M, Law H, Ying M. The Effect of Diabetes Self-Management Education on Body Weight, Glycemic Control, and Other Metabolic Markers in Patients with Type 2 Diabetes Mellitus. Journal of Diabetes Research 2014;Article ID 789761:

13. National Institute of Health. How are Overweight and Obesity Diagnosed? Version current 7/13/12. Internet: http://www.nhlbi.nih.gov/health/health-topics/topics/obe/diagnosis (accessed 4/12 2015).

14. Friedman AN, Miskulin DC, Rosenberg IH, Levey AS. Demographics and trends in overweight and obesity in patients at time of kidney transplantation. American Journal of Kidney Diseases 2003;41:480-7.

15. Kalantar-Zadeh K, Streja E, Kovesdy CP, Oreopoulos A, Noori N, Jing J, Nissenson AR, Krishnan M, Kopple JD, Mehrotra R, et al. The Obesity Paradox and Mortality Associated With Surrogates of Body Size and Muscle Mass in Patients Receiving Hemodialysis. Mayo Clin Proc 2010;85:991-1001.

16. Erwin Fleischmann, Nancy Teal, John Dudley, Warren May, John D Bower and Abdulla K Salahudeen. Influence of excess weight on mortality and hospital stay in 1346 hemodialysis patients. Kidney International 1999;55:1560-1567.

17. Kirsten L Johansen, Belinda Young, George A Kaysen, and Glenn M Chertow. Association of body size with outcomes among patients beginning dialysis. Am J Clin Nutr 2004;80: 2:324-332.

18. Gill JS, Lan J, Dong J, Rose C, Hendren E, Johnston O, Gill J. The Survival Benefit of Kidney Transplantation in Obese Patients. American Journal of Transplantation 2013;13:2083-90.

19. Starzl TE, Marchioro TL, Rifkind D, Holmes JH, Rowlands Jr DT, Waddell WD. Factors in Successful Transplantation. NIH Author Manuscript 1964;July 56:296-318.

20. Davidson J, WIlkinson A, Dantal J, Dotta F, Haller H, Hernandez D, Kasiske BL, Kieberd B, Krentz A, Legendre C, et al. New-Onset Diabetes After Transplantation: 2003 International Guidelines Consensus Guidelines. Transplantation 2003;75:10:SS3-SS24.

21. Pharm PT, Pham PT, Pham SV, Pham PT, Pham PT. New onset diabetes after transplantation (NODAT): an overview. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy 2011;4:175-186.

22. Kesiraju S, Paritala P, Rao Ch UM, Sahariah S. New onset of diabetes after transplantation — An overview of epidemiology, mechanism of development and diagnosis. Transpl Immunol 2014;30:52-8.

23. Kasiske BL, Snyder JJ, Gilbertson D, Matas AJ. Diabetes Mellitus after Kidney Transplantation in the United States. American Journal of Transplantation 2003;3:178-85.

24. Rodrigo E, Fernández-Fresnedo G, Valero R, Ruiz JC, Piñera C, Palomar R, González-Cotorruelo J, Gómez-Alamillo C, Arias M. New-Onset Diabetes after Kidney Transplantation: Risk Factors. Journal of the American Society of Nephrology 2006;17:S291-5.

25. Guerra J, Raimundo M, Teixeira C, Santana A, Cortesão A, Gomes da Costa A. Factors That May Influence Estimated Glomerular Filtration Rate in Patients With Excellent Graft Function 10 Years Posttransplant. Transplant Proc 2013;45:1060-2.

26. Kamar N, Mariat C, Delahousse M, Lefrançois N, Dantal J, Benhamou P. New Onset Diabetes Mellitus Incidence and Risk Factors in Kidney Transplantation: Results of the Observational Cross-Sectional Study Diapason. Transplant Proc 2006;38:2295-7.

27. Chakkera H, Knowler W, Devarapalli Y, Weil E, Heilman R, Dueck A, Mulligan D, Reddy K, Moss A, Mekeel K, et al. Relationship between inpatient hyperglycemia and insulin treatment after kidney transplantation and future new onset diabetes mellitus. CJASN 2010;9:1669-1675.

28. Fridlyand L, Philipson L. Does the Glucose-Dependent Insulin Secretion Mechanism Itself Cause Oxidative Stress in Pancreatic β-Cells? Diabetes 2004;53:8:1942-1948.

29. Kaiser N, Leibowitz G, Nesher R. Glucotoxicity and beta-cell failure in type 2 diabetes mellitus. J Pediatr Endocrinol Metab 2003;16(1):5-22.

30. Heit J, Apelqvist A, Gu X, Winslow M, Neilson J, Crabtree G, Kin S. Calcineurin/NFAT signalling regulates pancreatic beta-cell growth and function. Nature 2006;443:345-349.

31. Shirali AC, Bia MJ. Management of Cardiovascular Disease in Renal Transplant Recipients. Clinical Journal of the American Society of Nephrology 2008;3:491-504.

32. Rocha A, Malheiro J, Martins LS, Fonseca I, Dias L, Pedroso S, Almeida M, Henriques AC. Kidney Transplantation in Type 2 Diabetic Patients: A Matched Survival Analysis. Transplant Proc 2013;45:2141-6.

33. Salinardi T, Batra P, Roberts S, Urban L, Robinson L, Pittas A, Lichtenstein A, Deckersbach T, Saltzman E, Krupa Das S. Lifestyle intervention reduces body weight and improves cardiometabolic risk factors in worksites. Am J Clin Nutr 2013;97: 4:667-676.

34. Almeida F, Shetterly S, Smith-Ray R, Estabrooks P. Reach and Effectiveness of a Weight Loss Intervention in Patients with Prediabetes in Colarado. Preventing Chronic Disease: Public Health Research, Practice, and Policy 2010;7(5):

35. Lopes IM, Martín M, Errasti P, Martínez JA. Benefits of a dietary intervention on weight loss, body composition, and lipid profile after renal transplantation. Nutrition 1999;15:7-10.

36. Burani J, Longo P. Low-Glycemic Index Carbohydrates: An Effective Behavioral Change for Glycemic Control and Weight Management in Patients with Type 1 and 2 Diabetes. The Diabetes Educator 2006;32(1):78-88.

37. Adachi M, Yamaoka K, Watanabe M, Nishikawa M, Kobayashi I, Hida E, Tango T. Effects of lifestyle education program for type 2 diabetes patients in clinics: a cluster randomized controlled trial. BMC Public Health 2013;13:467.

38. Booth AO, Lowis C, Dean M, Hunter SJ, McKinley MC. Diet and physical activity in the self-management of type 2 diabetes: barriers and facilitators identified by patients and health professionals. Primary Health Care Research & Development 2013;14:293-306.

39. Miller CK, Kristeller JL, Headings A, Nagaraja H. Comparison of a Mindful Eating Intervention to a Diabetes Self-Management Intervention Among Adults With Type 2 Diabetes: A Randomized Controlled Trial. Health Education & Behavior 2013;

40. Locke EA. Toward a theory of task motivation and incentives. Organ Behav Hum Perform 1968;3:157-89.

41. Locke E, Latham G. A theory of goal setting & task performance. Prentice Hall College Div, 1990.

42. Bovend'Eerdt TJ, Botell RE, Wade DT. Writing SMART rehabilitation goals and achieving goal attainment scaling: a practical guide. Clinical Rehabilitation 2009;23:352-61.

43. Falter K, McCathy M, McGuire J. Assessment of Nutrition Education Handouts for Post-Renal Transplant Patients. 34(1) ed. Renal Nutrition Forum: Renal Dietitians Dietetic Practice Group, 2015. [Peer Reviewed Publication

44. Blass KG, Thibert RJ, Lam LK. A study of the mechanism of the jaffe reaction. Zeitschrift fur Klinische Chemie and Klinische Biochemie 1974;12(7):336-343.

45. Anonymous Estimating Glomerular Filtration Rate: MDRD Study Equation. Version current 5 February 2014. Internet: http://nkdep.nih.gov/lab-evaluation/gfr/estimating.shtml (accessed 21 September 2014).

46. Austin P. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. Multivariate Behav Res 2011;46(3):399-424.

47. Hjelmesaeth J, Harmann A, Leivestad T, Holdaas H, Sagedal S, Olstad M, Jenssen T. The impact of early-diagnosed new-onset post-transplant diabetes mellitus on survival and major cardiac events. Kidney International 2006;69(3):588-595.

48. de Mattos AM, Prather J, Olyaei AJ, Shibagaki Y, Keith DS, Norman DJ, Becker T. Cardiovascular events following renal transplantation: role of traditional and transplant specific risk factors. Kidney International 2006;70(4):757-764.

Appendix A: Data Collection Worksheet

Implementation of Nutrition Education Handout for Post-Renal Transplant Patients

Study ID: _____ Sex: M / F Hispanic Ethnicity: Y / N

DOB: _____ Race: _____

Length of hospital stay: _____ Etiology of ESRD: _____

Type of Kidney Donation: _____

Clinic Visit:

Date: _____ Age: _____ Ht: _____

Pre-Transplant:

Wt: _____

BMI: _____

Dx of DM: Y / N DM Regime: _____
Dosage:_____

Current:

Wt: _____

BMI: _____

Dx of NODAT: Y / N DM Regime: _____
Dosage:_____

Medication:

Induction immunosuppressant Rx: _____
Maintenance immunosuppressant Rx: _____
Insulin: _____
Oral diabetic Rx: _____

Labs:

Plasma creatinine concentration: _____ eGFR: _____

Hepatitis C: Y / N

Post-Transplant Dialysis: Y/ N

Handout: _____

S.M.A.R.T. Goal: _____

S.M.A.R.T. Goal: Met / Not Met

Appendix B: Glycemic Control Handout

2014

Controlling Blood Sugar after a Kidney Transplant

What is New-onset Diabetes after Transplant (NODAT)?

NODAT is constant high blood sugar after an organ transplant in patients who did not have a history of diabetes before surgery. When diet and exercise are not enough, medicine may be needed to help lower blood sugar.

Two NODAT Risk Factors:

- Immunosuppressant medicine
- Being overweight

Chronically High Blood Sugar Can Cause:

- Loss of kidney function
- Heart disease
- Infection

What Causes High Blood Sugar?

Immunosuppressant medications are needed to decrease the chance of the body rejecting the transplanted organ, and these medications can increase:

- Blood sugar
- Appetite and lead to weight gain

How Can Diet Help?

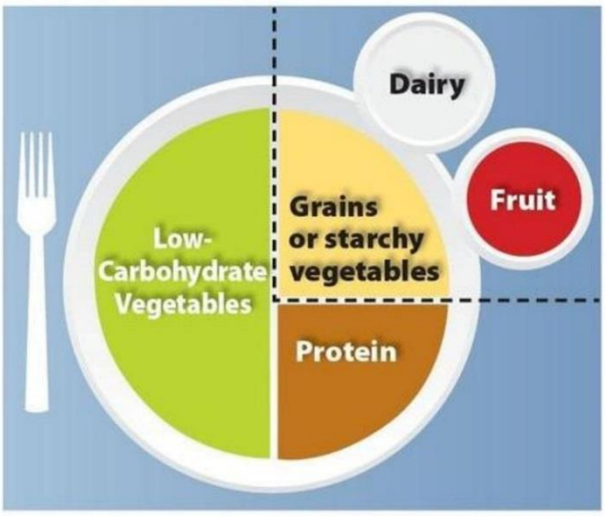
- Foods that contain carbohydrates will raise blood sugar
- Carbohydrates from grains, vegetables, fruits, and low-fat dairy should be eaten for good health instead of other carbohydrates that contain added sugar and fat
- Eating the same amount of carbohydrates around the same time each day can help control blood sugar levels

Target Blood Sugar Values

- Hemoglobin A1c: 7%
- Pre-prandial (before a meal): 70 – 130 mg/dl
- 1 – 2 hours post-prandial (after the start of the meal): less than 180 ml/dl

Ranges may vary depending on individual needs

The Plate Method: Carbohydrate Control



What Is It?

The Plate Method is a tool that allows us to portion food without actually measuring it. It can be used for blood sugar control and/or weight maintenance. The Plate Method will help keep carbohydrate intake at meals around the same amount. Meals and snacks should be eaten around the same time daily to further help with blood sugar control.

Basic concepts:

- A 9-inch diameter plate
- Food stacked 1-inch high

Dairy (1 cup):

- 12 grams carbohydrates
- Skim or 1% milk (1 cup) and light yogurt (6 ounces)*

Protein (¼ plate):

- 0 grams carbohydrate
- Chicken, beef, fish, eggs, and tofu*

Fruit (½ cup):

- 15 grams carbohydrates
- Fruit contains natural sugars
- Small apple, small banana, small orange, and ½ cup grapes*

Grains or Starchy Vegetables (¼ plate):

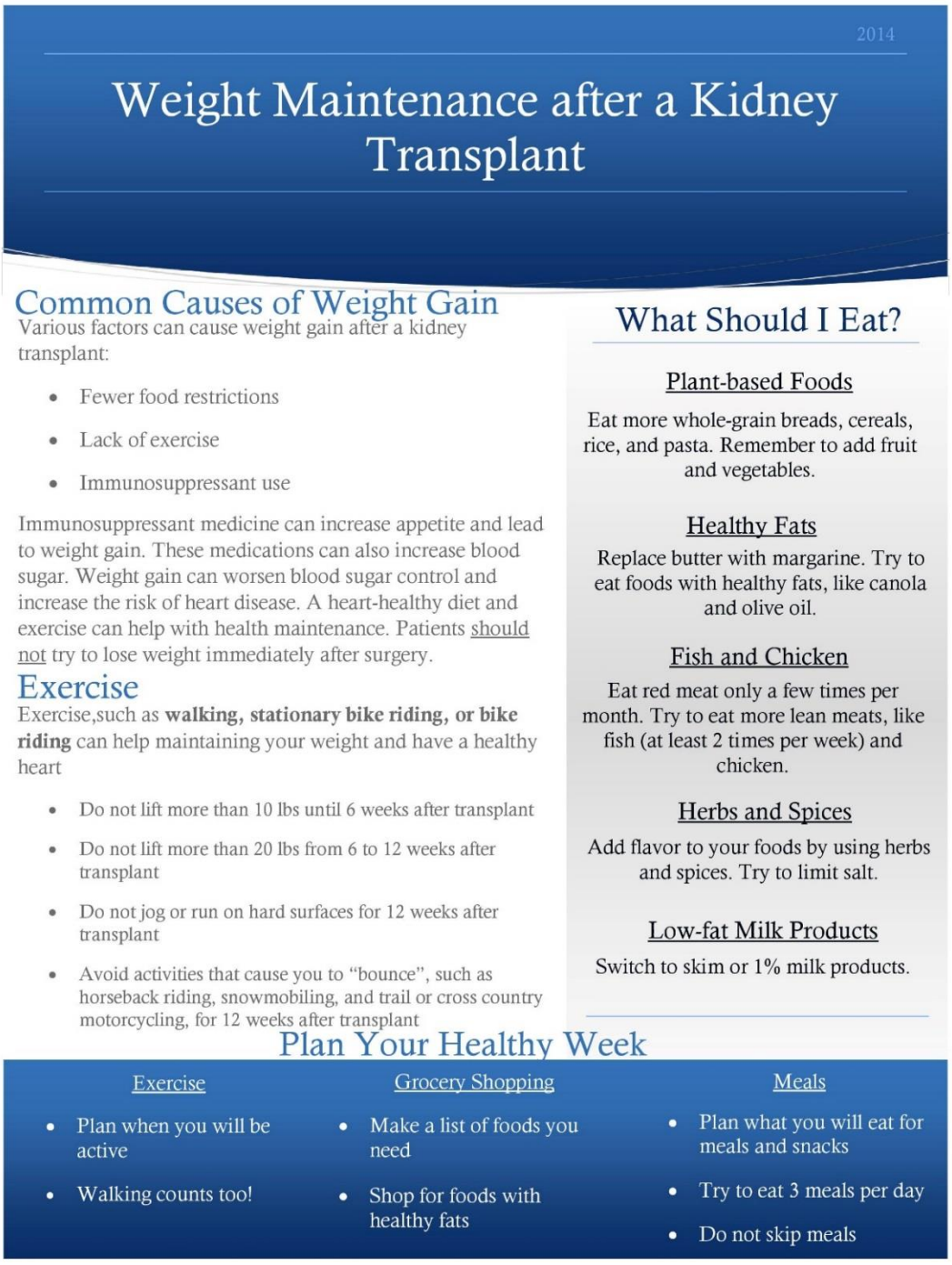
- 15 grams carbohydrates
- This group contains more carbohydrates than non-starchy vegetables, so it makes up ¼ of the plate
- Grains: rice, crackers, whole-grain bread, tortilla, pasta, and English muffin*
- Starchy vegetables: corn, green peas, garbanzo beans, potatoes, and lima beans*

Non-starchy Vegetables (½ plate):

- 5 grams carbohydrates
- Non-starchy vegetables include half the plate because they contain very few carbohydrates
- Asparagus, green beans, brussels sprouts, celery, lettuce, and broccoli*

*For more information on food choices please visit: www.diabetes.org

Appendix C: Weight Management Handout



2014

Weight Maintenance after a Kidney Transplant

Common Causes of Weight Gain

Various factors can cause weight gain after a kidney transplant:

- Fewer food restrictions
- Lack of exercise
- Immunosuppressant use

Immunosuppressant medicine can increase appetite and lead to weight gain. These medications can also increase blood sugar. Weight gain can worsen blood sugar control and increase the risk of heart disease. A heart-healthy diet and exercise can help with health maintenance. Patients should not try to lose weight immediately after surgery.

Exercise

Exercise,such as **walking, stationary bike riding, or bike riding** can help maintaining your weight and have a healthy heart

- Do not lift more than 10 lbs until 6 weeks after transplant
- Do not lift more than 20 lbs from 6 to 12 weeks after transplant
- Do not jog or run on hard surfaces for 12 weeks after transplant
- Avoid activities that cause you to "bounce", such as horseback riding, snowmobiling, and trail or cross country motorcycling, for 12 weeks after transplant

What Should I Eat?

Plant-based Foods

Eat more whole-grain breads, cereals, rice, and pasta. Remember to add fruit and vegetables.

Healthy Fats

Replace butter with margarine. Try to eat foods with healthy fats, like canola and olive oil.

Fish and Chicken

Eat red meat only a few times per month. Try to eat more lean meats, like fish (at least 2 times per week) and chicken.

Herbs and Spices

Add flavor to your foods by using herbs and spices. Try to limit salt.

Low-fat Milk Products

Switch to skim or 1% milk products.

Plan Your Healthy Week

Exercise

- Plan when you will be active
- Walking counts too!

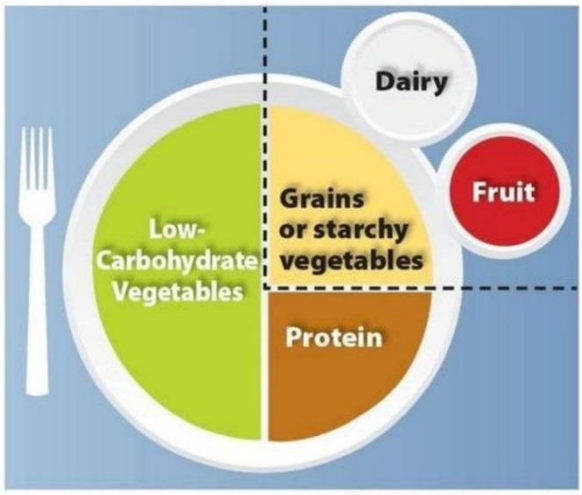
Grocery Shopping

- Make a list of foods you need
- Shop for foods with healthy fats

Meals

- Plan what you will eat for meals and snacks
- Try to eat 3 meals per day
- Do not skip meals

The Plate Method: Weight Maintenance



What Is It?

The Plate Method is a tool that allows us to portion food without actually measuring it. It can be used for weight maintenance. The Plate Method will help control the amount of calories you put on your plate for each meal.

Basic concepts:

- A 9-inch diameter plate
- Food stacked 1-inch high

Dairy (1 cup):

- Skim or 1% milk (1 cup) and light yogurt (6 ounces)*

Protein (¼ plate):

- Chicken, fish, eggs, and tofu*
- Reduce salt intake by avoiding packaged and processed meats

Fruit (½ cup):

- Small apple, small banana, ½ cup grapes, and small orange*

Grains or Starchy Vegetables (¼ plate):

- Grains: rice, crackers, whole-grain bread, tortilla, pasta, and English muffin*
- Starchy vegetables: corn, green peas, garbanzo beans, potatoes, and lima beans*

Non-starchy Vegetables (½ plate):

- Non-starchy vegetables contain fewer calories than starchy vegetables*
- Asparagus, green beans, brussels sprouts, celery, lettuce, and broccoli*

*For more information on food choices please visit: www.diabetes.org

Appendix D: Research Consent Summary

IRB#: 10727

Research Consent Summary

You are being asked to join a research study. You do not have to join the study. Even if you decide to join now, you can change your mind later.

1. The purpose of this study is to clinically validate handouts in post-renal transplant recipients that increase the knowledge of controlling blood sugar and/or weight control and increase motivation for behavior change.

2. We want to learn
    1. The effectiveness of the blood sugar control education by measuring the use of insulin or oral diabetic agents before and after the use of the handout(s)
    2. The effectiveness of the weight management control education by measuring weight and BMI before and after the use of the handout(s)
    3. The effectiveness of S.M.A.R.T. goals for dietary changes.

3. This study requires 3 clinic visits to the Oregon Health & Science University's Kidney Transplant Clinic and each will take about 15–20 minutes. These appointments will take place during routine visits to the Post-Kidney Transplant Clinic. On the first clinic visit, you will receiving a blood sugar control and/or weight control handout, participate in a nutrition education session, and asked to create one (1) S.M.A.R.T. goal for your diet. For all clinic appointments, you will have your weight checked, your routine labs analyzed, and your medications analyzed. On the second and third clinic appointment, you will receive a review of the nutrition education handout and your S.M.A.R.T. goal.

4. There is a small risk of breach of confidentiality.

5. If you agree, information collected during the study may be saved for future research.

OREGON HEALTH & SCIENCE UNIVERSITY

IRB#: 11035

Research Consent and Authorization Form

TITLE: Implementation of Nutrition Education Handouts for Post-Renal Transplant Patients

PRINCIPAL INVESTIGATOR: *Maureen McCarthy* MPH, RD, LD, CSR
(503) 494-3779

CO-INVESTIGATORS: Amanda Rosenberg
(503) 494-3779

PURPOSE:

You have been invited to be in this research study because you have at least one of two risk factors for new-onset diabetes after transplantation (NODAT). The purpose of this study is to assess glycemic control and/or monitor weight management in kidney transplant recipients that will receive nutrition education.

This study requires 3 visits to the Oregon Health & Science University's Kidney Transplant Clinic and will take about 15 – 20 minutes.

Expected enrollment is about 30 participants at Oregon Health & Science University's Kidney Transplant Clinic.

PROCEDURES:

If you consent to be in the study, you will participate in a 15 - 20 minute motivation assessment and education session at your second post-op clinic visit using either a blood sugar control and/or weight control handout. You will create a specific, measurable, attainable, realistic, and timely (S.M.A.R.T.) goal. At six (6) weeks and three months post-transplant, you will participate in a 15-20 minute follow-up that will review the

educational hand-out and review your selected S.M.A.R.T. goal. You will state whether the S.M.A.R.T. goal is met or not met to assess how you are meeting the self-appointed goal. The intervention will last approximately three (3) months.

All information will be gathered from your medical chart in EPIC. Baseline data will be collected at the time of hospital admission for the kidney transplant surgery and will include age, sex, race/ethnicity, weight, body mass index (BMI), height, etiology of end-stage renal disease (ESRD), the type of kidney donation, the components of diabetes mellitus treatment regime, plasma creatinine concentrations, estimated glomerular filtration rate (eGFR), types of induction and maintenance immunosuppressant medications. Outcome data will be collected at the time of hospital discharge, at six (6) weeks, and at three (3) months post-transplant. This data will include weight, BMI, maintenance immunosuppressant therapy, components of diabetes mellitus (DM) treatment regime, new diagnosis of New-Onset Diabetes After Transplant (NODAT), plasma creatinine concentration, eGFR, post-transplant dialysis status, duration of hospital admission, and delayed graft function (dialysis required during the transplant admission) or graft failure (maintenance dialysis required after transplant).

If you have any questions regarding this study now or in the future, contact Maureen McCarthy (503) 494-3779 or Amanda Rosenberg at (503) 494-3779.

RISKS AND DISCOMFORTS:

Although we have made every effort to protect your identity, there is a minimal risk of loss of confidentiality.

BENEFITS:

You may or may not personally benefit from being in this study. However, by serving as a participant, you may help us learn how to benefit patients in the future.

ALTERNATIVES:

You may choose not to be in this study.

CONFIDENTIALITY:

We will take steps to keep your personal information confidential, but we cannot guarantee total privacy.

We will create and collect health information about you as described in the Purpose and Procedures sections of this form. Health information is private and is protected under federal law and Oregon law. By agreeing to be in this study, you are giving permission (also called authorization) for us to use and disclose your health information as described in this form.

We may release this information to others outside of OHSU who are involved in conducting or overseeing research, including:

- The Office for Human Research Protections, a federal agency that oversees research involving humans

We will not release information about you to others not listed above, unless required or permitted by law. We will not use your name or your identity for publication or publicity purposes, unless we have your special permission.

Data from this study may be shared with other investigators for future research studies. All identifying information about you will be removed before they are released to any other investigators.

We may continue to use and disclose your information as described above indefinitely.

Some of the information collected and created in this study may be placed in your OHSU medical record. While the research is in progress, you may or may not have access to this information. After the study is complete, you will be able to access any study information that was added to your OHSU medical record. If you have questions about what study information you will be able to access, and when, ask the investigator.

COSTS:

There will be no cost to you or your insurance company to participate in this study.

LIABILITY:

If you believe you have been injured or harmed while participating in this research and require immediate treatment, contact Maureen McCarthy (503) 494-3779**.**

You have not waived your legal rights by signing this form. If you are harmed by the study procedures, you will be treated. Oregon Health & Science University does not offer to pay for the cost of the treatment. Any claim you make against Oregon Health & Science University may be limited by the Oregon Tort Claims Act (ORS 30.260 through 30.300). If you have questions on this participant, please call the OHSU Research Integrity Office at (503) 494-7887.

PARTICIPATION:

If you have any questions regarding your rights as a research participant, you may contact the OHSU Research Integrity Office at (503) 494-7887.

You do not have to join this or any research study. You do not have to allow the use and disclosure of your health information in the study, but if you do not, you cannot be in the study.

If you do join the study and later change your mind, you have the right to quit at any time. This includes the right to withdraw your authorization to use and disclose your health information. If you choose not to join any or all parts of this study, or if you withdraw early from any or all parts of the study, there will be no penalty or loss of benefits to which you are otherwise entitled, including being able to receive health care services or insurance coverage for services. Talk to the investigator if you want to withdraw from the study.

If you no longer want your health information to be used and disclosed as described in this form, you must send a written request or email stating that you are revoking your authorization to:

Maureen McCarthy

3181 SW Sam Jackson Park Rd

UHS 18

Portland, OR 97239

mccarthm@ohsu.edu

Your request will be effective as of the date we receive it. However, health information collected before your request is received may continue to be used and disclosed to the extent that we have already acted based on your authorization.

If you choose to withdraw from this study no further action will be needed on your part.

If in the future you decide you no longer want to participate in this research, we will remove your name and any other identifiers from your information, but the material will not be destroyed and we will continue to use it for research.

You may be removed from the study if the investigator or sponsor stops the study.

We will give you any new information during the course of this research study that might change the way you feel about being in the study.

SIGNATURES:

Your signature below indicates that you have read this entire form and that you agree to be in this study.

We will give you a copy of this signed form.

OREGON HEALTH & SCIENCE UNIVERSITY

INSTITUTIONAL REVIEW BOARD

PHONE NUMBER (503) 494-7887

CONSENT/AUTHORIZATION FORM APPROVAL DATE

Sep. 8, 2014

Do not sign this form after the

expiration date of: Sep. 07, 2015

Participant Printed Name	Participant Signature	Date

Person Obtaining Consent Printed Name	Person Obtaining Consent Signature	Date

Complete if the participant is not fluent in English and an interpreter was used to obtain consent. Participants who do not read or understand English must not sign this full consent form, but instead sign the short form translated into their native language. This form should be signed by the investigator and interpreter only.

Print name of interpreter: _____

Signature of interpreter: _____ Date: _____

An oral translation of this document was administered to the participant in _____ (state language) by an individual proficient in English and _____ (state language).

See the attached short form for documentation.

Citations	Study Designs	Subjects/Characteristics	Outcomes
Kamar,N.; Mariat,C.; Delahousse,M.; Lefrançois,N.; Dantal,J.; Benhamou,P. New Onset Diabetes Mellitus Incidence and Risk Factors in Kidney Transplantation: Results of the Observational Cross-Sectional Study *Transplant.Proc.*, 2006, 38(7) 2295-2297	Observational cross-sectional study France	N= 527 Median age = 48.5 years old	37 (7%) of pts developed NODAT within a median time of 1.6 months. NODAT risk factors: • Recipient age over 45 • Impaired fasting glucose before transplant • Presence of 2 cardiovascular risk factors • Positive hep C • BMI over 25 • Tacrolimus treatment
Cacciola,R.A.S.; Pujar,K.; Ilham,M.A.; Puliatti,C.; Asderakis,A.; Chavez,R. Effect of Degree of Obesity on Renal Transplant Outcome *Transplant.Proc.*, 2008, 40(10) 3408-3412	Retrospective study using data from the Proton database from 1993-2003 Cardiff, Wales	n=114 Group A: BMI between 30-34.9 kg/m^2 (n=90) Group B: BMI greater than 35 kg/m^2 (n=24)	12.5% of Group A had DM 19% of Group B had DM 5 year graft survival: • Group A: 94.5% • Group B: 63% 5 year patient survival: • Group A: 95.6% • Group B: 79.2%
Demirci,M.; Toz,H.; Yilmaz,F.; Ertilav,M.; Asci, G.; Ozkahya,M.; Zeytinoglu,A.; Nart,D.; Ok,E. Risk factors and consequences of post-transplant diabetes mellitus. *Clin.Transplant*., 2010, 24(5) E170-E177	Retrospective Izmir, Turkey	N=555	The frequency of PTDM was 18.3% (n=102). PTDM happened: • 51% in the first 3 months • 23.5% in 3-12 months • 25.5% in beyond 1 year Risk factors for PTDM: • Age • Dialysis duration • BMI before transplant • Hepatitis C virus

Gill,J.S.; Lan,J.; Dong,J.; Rose,C.; Hendren,E.; Johnston,O.; Gill,J. The Survival Benefit of Kidney Transplantation in Obese Patients *American Journal of Transplantation*, 2013, 13(8) 2083-2090	Retrospective	N=118,662 Pts were captured in the US Renal Data System who initiated their first ESRD treatment between 4/1/1995 and 9/31/2007 and were activated onto the deceased donor waiting list.	Deaths after transplant: • 15% had a BMI of <18.5 kg/m^2 • 11% had a BMI of 18.5-24.9 kg/m^2 • 11% had a BMI of 25-29.9 kg/m^2 • 11% had a BMI of 30-34.9 kg/m^2 • 11% had a BMI of 35-39.9 kg/m^2 • 12% had a BMI of >40 kg/m^2
Grosso,G.; Corona,D.; Mistretta,A.; Zerbo,D.; Sinagra,N.; Giaquinta,A.; Caglià,P.; Amodeo,C.; Leonardi,A.; Gula,R.; Veroux,P.; The Role of Obesity in Kidney Transplantation Outcome *Transplant.Proc.*, 2012, 44(7) 1864-1868	Retrospective	N=376 Consecutive renal transplant recipients from May 2000 to December 2010.	Non-obese (n= 313) • Graft loss at 1 year=5.3% • Graft loss at 3 years=7.7% Obese (n=64) • Graft loss at 1 year=6.4% • Graft loss at 3 years=42.9%
Johny,K.V.; Nampoory,M.R.N.; Costandi,J.N.; Gupta,R.K.; Ninan,V.T.; Samhan,M.; Muzairai,I.; Al-Mousawi,M. High incidence of post-transplant diabetes mellitus in Kuwait *Diabetes Res.Clin.Pract.*, 2002, 55(2) 123-130	Retrospective study using data from January 1983 to January 1998. Nephrology Unit of Mubarak Al-Kabeer Hospital Hamad Al-Essa Organ Transplant Centre in Kuwait	N=631 79 had pre-transplant DM 552 did not have DM	117 (21.2%) pts developed PTDM <30 years old 7.7% PTDM 31-45 years old 38.5 PTDM 46-60 years old 47% PTDM >61 years old 6.8% PTDM PTDM occurred during in the first year of 55.5% Diet modification, wt reduction and regular physical activity could keep blood sugar under control in 19.7% of PTDM cases.

Cullen, T; McCarthy, M; Lasarev, M; Barry, J; Stadler, D. Body Mass Index and the Development of New-Onset Diabetes Mellitus or the Worsening of Pre-Existing Diabetes Mellitus in Adult Kidney Transplant Recipients *Journal of Renal Nutrition*, 2014, 24(2) 116-122	Retrospective study using data from September 2009 to February 2011. Oregon Health & Science University Portland, Oregon	N=204 98 developed NODAT	BMI was significantly associated with development of NODAT at hospital discharge, 3 month and 6 months after transplant.
Johny,K.V.; Nampoory,M.R.N.; Costandi,J.N.; Gupta,R.K.; Ninan,V.T.; Samhan,M.; Muzairai,I.; Al-Mousawi,M. High incidence of post-transplant diabetes mellitus in Kuwait *Diabetes Res Clin Pract*., 2002, 55(2) 123-130	Retrospective study using data from January 1983 to January 1998. Nephrology Unit of Mubarak Al-Kabeer Hospital Hamad Al-Essa Organ Transplant Centre in Kuwait	N=631 79 had pre-transplant DM 552 did not have DM	117 (21.2%) pts developed PTDM <30 years old 7.7% PTDM 31-45 years old 38.5 PTDM 46-60 years old 47% PTDM >61 years old 6.8% PTDM PTDM occurred during in the first year of 55.5% Diet modification, wt reduction and regular physical activity could keep blood sugar under control in 19.7% of PTDM cases.
Joss,N; Staatz,C.; Thomson,A.; Jardine,A. Predictors of new onset diabetes after renal transplantation *Clin Transplant*., 2007, 21(1) 136-143	Retrospective study Renal transplants performed from 1994-2004. Scotland	N=787 Data included: • Age, wt at transplantation, gender, ethnicity, residential post code (socioeconomic). • Serum creatinine • HbA1c	55 pts were diagnosed with NODAT 32 pts were diagnosed with NODAT within the first year. NODAT pts were: • Older: 49 +/- 12 years old vs 40 +/- 13 years old • Heavier : 78 +/- 18 kg vs 69 +/- 14 • Had higher plasma glucose on post op day 1: 12.8 +/- 6.8 vs 10.5 +/- 4.7 mmol/L

Sharif, A; Moore, R; Baboolal, K. Influence of Lifestyle Modification in Renal Transplant Recipients with Postprandial Hyperglycemia *Transplantation*, 2008, 85(3) 353-358	Experimental Study Lifestyle modification with dietitian referral, graded exercise program, and weight loss advice. 6 month follow-up Cardiff, Wales	N=118 Group 1: Glucose intolerance n=36 Group 2: Normal glucose tolerance n=79	NODAT (n=7) • 3 NODAT • 2 IGT • 2 Normal Impaired Glucose Tolerance (n=25) • 1 NODAT • 13 IGT • 11 Normal Normal Glucose Tolerance (n=79) • 2 NODAT • 10 IGT • 67 Normal
Marks, W; Florence, L; Chapman, P; Precht, A; Perkinson, D. Morbid Obesity is not a Contraindications to Kidney Transplantation *The American Journal of Surgery, 2004, 18, 635-638*	Retrospective study January 1995 to February 2000 Seattle, Washington	N=247	3 year graft survival-deceased donor (p=0.09) • 90% non-obese recipients • 75% morbidly obese recipients Length of stay was significantly longer for morbidly obese recipients (p<0.05) Morbidly obese recipients had a higher rate of major wound infections, 30% vs 3%
Lopes, M; Martin, M; Errasti, P; Martinez, A. Benefits of a dietary intervention on weight loss, body composition, and lipid profile after renal transplantation. *Applied Nutritional Investigation, 1999, 15(1), 7-10*	Experimental study AHA Step One diet: • <30% calories from fat • <10% calories from saturated fat • <300 mg cholesterol/day • 30% energy reduction Follow-up 6 months	N=23	3 kg weight loss (p<0.01) 1.3 decrease in BMI (p<0.01) 13 mg/dL decrease in cholesterol (p<0.05)