ASSESSING NUTRITONAL RISK OF THE POST-ACUTE LIVER TRANSPLANT POPULATION

by

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DEDICATION

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ABSTRACT

Background. Although nutritional deficiency is known to be both common and multifactorial in the post-liver transplant population, a global systematic method of assessing nutritional status has not been widely implemented. The Subjective Global Assessment has been validated in many clinical populations, but to this investigator's knowledge there are no reports on its use in the post-acute liver transplant population. The purpose of this Doctorate of Nursing Practice project was to assess nutritional risk using a Nutritional Assessment Tool, consisting of the Subjective Global Assessment plus additional indicators, for use in the post-acute liver transplant population, defined as one week or less after hospital discharge from liver transplant. The additional indicators consist of age, body mass index, Model for End-Stage Liver Disease score, hospital length of stay for liver transplant, and diagnosis of diabetes mellitus. *Methods.* This was a practicality study in which a Nutritional Assessment Tool was administered by advanced practice nurses to post-acute liver transplant patients in an outpatient clinic. Each advanced practice nurse completed a practicality survey. Dependence of the additional indicators on the Subjective Global Assessment classification was evaluated using ANOVA and Fisher's exact test. Time to administer the tool was also collected. *Results.* Seventeen participants were enrolled over a period of three months. Among these, 70.5% were ranked as well-nourished, 23.5% as moderately malnourished, and 5.9% as severely malnourished. No statistically significant dependence of the indicators on the Subjective Global Assessment classification was found. The average time to administer the tool was 9.7+/- 2.4 minutes. Based on the survey from advanced practice nurses, the Nutritional Assessment Tool was found to be practical in this outpatient clinic setting. *Conclusions.* Implementing a Nutritional Assessment Tool, or the

Subjective Global Assessment at minimum, in the post-acute liver transplant population in this setting served to be a practical method of evaluating global nutritional risk.

CHAPTER I INTRODUCTION

End-Stage Liver Disease and Liver Transplant

The liver is the largest internal organ, weighing approximately three pounds, and is responsible for many functions throughout the body. A few of these functions include synthesis of important proteins such as albumin and alpha-fetoprotein, detoxification of medications and drugs, metabolism of carbohydrates, lipids, and proteins, and production of factors such as vitamin K and angiotensinogen.

Liver disease is common, with prevalence estimated at 15% in the United States (US) (Younossi, Stepanova, Afendy, Fang, Younossi, Mir, & Srishhord, 2011), and is detrimental to many physiologic processes. Disease can occur due a multitude of reasons including viral infection with hepatitis B or C, alcoholism, metabolic disease, malignancies, and autoimmune disease. Although many options exist for treating these diseases, once the liver becomes cirrhotic and its function is compromised, the patient can suffer many consequences. Decompensated end-stage liver disease (ESLD) occurs when the patient suffers from complications such as gastrointestinal bleeding, hepatic encephalopathy, jaundice, esophageal varices, ascites, and spontaneous bacterial peritonitis. Without intervention, decompensated ESLD and cirrhosis are deadly, accounting for the 12th leading cause of mortality in the US (Centers for Disease Control and Prevention [CDC], 2013).

Liver transplantation has thus become the therapy of choice for patients with decompensated end-stage or acute fulminant liver failure. Although liver transplantation (LT) is life saving for this population, it is a major surgery that requires life-long immunosuppression and close medical attention. LT is not always curative, as the disease that caused the cirrhosis to occur can return, especially if it is a systemic disease such as hepatitis C infection.

LT allocation is based on scoring the patient's need for transplantation, using a calculation known as the Model for End-Stage Liver Disease (MELD). The MELD score encompasses a patient's serum creatinine level, total bilirubin level, international normalized ratio, and need for hemodialysis, and ranges from a score of six to forty. A higher MELD score indicates that the patient is very ill and in need for LT. A provider can apply for MELD exception points if they feel that the MELD score underestimates a patient's morbidity and need for LT. Exception points are granted by the United Network for Organ Sharing after a written request if approved by a review board. MELD exception points can be granted for conditions such as hepatocellular carcinoma within Milan criteria, hepatopulmonary syndrome, multiple episodes of cholangitis, refractory ascites, and intractable pruritus. The patient's MELD score, as well as their blood type, weight, height, and age are entered into the United Network for Organ Sharing database where potential donors and recipients are matched based on these entries, need, and geographical proximity. Wait time for a suitable donor varies based on the patient's blood type, region, and MELD score.

Nutritional Deficiency

In general, nutritional deficiency occurs when one or more essential nutrients are insufficient or completely lacking in the diet. Insufficient amounts of essential nutrients can occur due to poor intake, poor absorption, or a combination of both processes. Nutritional deficiency can worsen the prognosis of any chronic disease, especially chronic liver disease (Plauth, Merli, Kondrup, Weimann, Ferenci & Mueller, 1997). Nutritional deficiency is multifactorial in this population, and is estimated to occur at a rate of 65-90% in the US (O'Brien and Williams, 2008).

Since the liver is the organ most involved in metabolism, alterations in liver function can subsequently lead to nutritional deficiency. The diseased liver causes protein alterations in the body that are detrimental, such as increased loss of protein in the intestine and decreased protein synthesis (Hasse, 2001; Sanchez & Aranda-Michel, 2006). Patients with ESLD are thus prone to developing protein-energy malnutrition, with an estimated prevalence of 20% in compensated ESLD patients and 80% in decompensated patients (Sanchez & Aranda-Michel, 2006). Nutritional status is further compromised in ESLD by the formation of ascites and subsequent early satiety, alterations in mental status from hepatic encephalopathy, and the hypermetabolic state that coincides with cirrhosis (Hasse, 2001; Sanchez & Aranda-Michel, 2006; Latifi, Basadonna, & Marcos, 2001).

Nutritional deficiency is further influenced by factors associated with the disease which caused the liver to become cirrhotic. For example, patients with cholestatic liver disease, such as primary sclerosing cholangitis or primary biliary cirrhosis, may have malabsorption issues and patients with alcoholic cirrhosis may have electrolyte abnormalities which can interfere with their nutritional status (Sanchez & Aranda-Michel, 2006; Latifi et al., 2001). Patients with ESLD are more likely to develop anorexia, and are often put on restrictive diets as part of their treatment plan which further negatively impacts their nutritional intake (Hasse, 2001).

Nutritional Deficiency Post-Liver Transplant

Because of the nutritional deficiency associated with ESLD, LT recipients often enter the recovery phase from a major operation already compromised. Their nutritional status post-LT will depend on their pre-LT nutritional status and diet, graft function, co-morbidities, surgical and infectious complications, electrolyte imbalances, and method of immunosuppression (Hasse, 2001).

In the immediate post-operative phase, nutritional goals should include maintaining appropriate fluid and electrolyte balance, stabilizing blood glucose, and providing enough nutrition to counter the catabolic state (Hasse, 2001). This post-operative catabolic state is attributed to high levels of nitrogen being lost in the urine, requiring additional protein to avoid further protein deficiency (Sanchez & Arranda-Michel, 2006). It is also important for the LT recipient to have additional protein intake to help stabilize fluid retention in the body, so that ascites and edema can resolve early in the post-operative period. Having a sufficient nutritional intake post-LT may further be complicated by dysgeusia post-LT, pain, nausea, fatigue, and loss of appetite.

After the immediate post-operative period, maintaining an appropriate nutritional status remains vital for the LT recipient as the goals shift towards prevention of adverse outcomes such as metabolic syndrome, osteoporosis, and obesity. All immunosuppression medication regimens used after LT impact a recipient's nutritional status, but the direct impact depends on the type, dose, and duration of the medication used. De novo diabetes mellitus (DM) and obesity are common and are associated with the use of corticosteroids and calcineurin inhibitors, both mainstream therapies for immunosuppression post-LT (McPartland & Pomposelli, 2007, Hasse, 2001). Many of these medications, notably mycophenolate mofetil and mammalian targets of rapamycin inhibitors, are known to have significant gastrointestinal side effects such as nausea, mouth sores, and diarrhea, which can further aggravate a LT recipient's nutritional intake (McParkland & Pomposelli, 2007).

Tools to Assess Nutritional Status Post-Liver Transplant

Because of the high incidence of factors that affect their nutritional status, recipients require assistance maintaining a healthy lifestyle after LT. Monitoring these patients' nutrition status is key to both the recovery from surgery and the prevention of adverse effects such as obesity and metabolic syndrome (Plauth et al., 1997). Based on this monitoring, recommended interventions may include maintaining appropriate blood glucose, protein, lipid, and calcium levels as well as a healthy weight. LT recipients may also need guidance on carbohydrate counting, heart healthy diets, and appropriate protein and calcium supplementation (Sanchez & Aranda-Michel, 2006).

Although nutritional status is agreed to be an important factor in overall outcomes in the LT recipient, studies specifically examining the benefit of nutritional status vary with respect to outcomes observed (Shahid, Johnson, Nightingale, & Neuberger, 2005, Stephenson et al., 2001; Latifi et al, 2001, Pikul et al, 1994). In general, studies have associated poor nutritional status pre-LT with both negative health outcomes and increased use of healthcare services (Shahid et al, 2005, Stephenson et al., 2001; Latifi et al, 2001, Pikul et al, 1994). Nutritional status has been assessed by various methods including subjective questionnaires, laboratory data, and anthropometric measurements (Shahid et al, 2005, Stephenson et al., 2001; Latifi et al, 2001, Pikul et al, 1994). Many conventional nutritional markers, such as weight, body mass index (BMI), pre-albumin, albumin, and anthropometric measurements that are considered gold-standard in other clinical populations can be seriously confounded in the LT population due to the presence of ascites, edema, and the underlying liver disease (Barbosa-Silva & Barros, 2006; Sanchez & Aranda-Michel, 2006; Hasse, 2001). Bioimpedance analysis can be used to estimate body cell mass, but is inaccurate when third-spacing exists, and is a costly measurement tool that is impractical in an outpatient clinic visit (Plauth et al, 1997). Thus, a rapid global nutritional assessment is warranted for evaluating nutritional risk in the post-acute LT patient population.

Because they are not highly affected by liver disease, subjective measures of nutritional status have shown to be of use in the pre-LT population (Stephenson et al., 2001). Subjective data collected about a LT recipient's nutritional status may contribute information such as patient's dietary habits, physical function, recent changes in weight, and significant medical symptoms that may affect their intake.

The Subjective Global Assessment (SGA; Appendix A) is a widely-used and validated tool used for global screening of nutritional risk in both the general population and in a variety of specific clinical populations including patients with need for hemodialysis (Jones et al, 2004), general medical patients (Planas et al, 2004), elderly patients (Faxen-Irving et al, 2005), severely ill (Acosta Escribano et al, 2005), cirrhotics (Gottschall et al, 2004), pediatric patients (ASPEN Board of Directors, 2002), oncology patients (Ottery, 1996), patients with colorectal cancer (Gupta et al, 2005), patients with gynecologic cancer (Santoso et al, 2004), orthopedic surgery patients (Murat et al, 2007), patients requiring mechanical ventilation (Sheean et al, 2010), and pre-LT patients (Pikul et al, 1994, Stephenson et al, 2001, Figueiredo et al, 2000). The SGA includes an assessment of the patient's history using subjective data, as well as a focused physical exam in order to provide a comprehensive evaluation of the LT recipient's nutritional status. The SGA is intended to be used as a global assessment, or a screening tool for nutritional risk and associated complications, to determine which patients require a more formalized assessment by a trained dietician (Plauth et al, 1997; Detsky et al, 1984). Because it is a well-tested and validated tool that has been shown to be relevant universally, the SGA is largely considered a gold standard for screening for nutritional risk (Barbosa-Silva & Barros, 2006).

Although screening with the SGA has been validated in many clinical populations, including cirrhotic patients and pre-LT patients, to this investigator's knowledge there are no reports its use in the post-acute LT population. This represents a gap in knowledge and in clinical practice which may lead to a lack of standardization with respect to measures used to assess patient's nutritional risk or, more importantly, not addressing this important issue at all.

Theoretical Model

The Roper-Logan-Tierney (R-L-T) Model of Nursing is a conceptual nursing model created by Nancy Roper, Winifred Logan, and Alison Tierney in 1980 which describes considering a patient holistically, with focus placed on activities of daily life (ADLs) (Roper, Logan, & Tierney, 2000). According to this model, nurses should consider ADLs a major aspect of quality of life for their patients and should assess these aspects in detail not simply as part of a checklist. The model further states that a patient's ability to be independent or dependent with these various ADLs will change throughout the course of their lifespan.

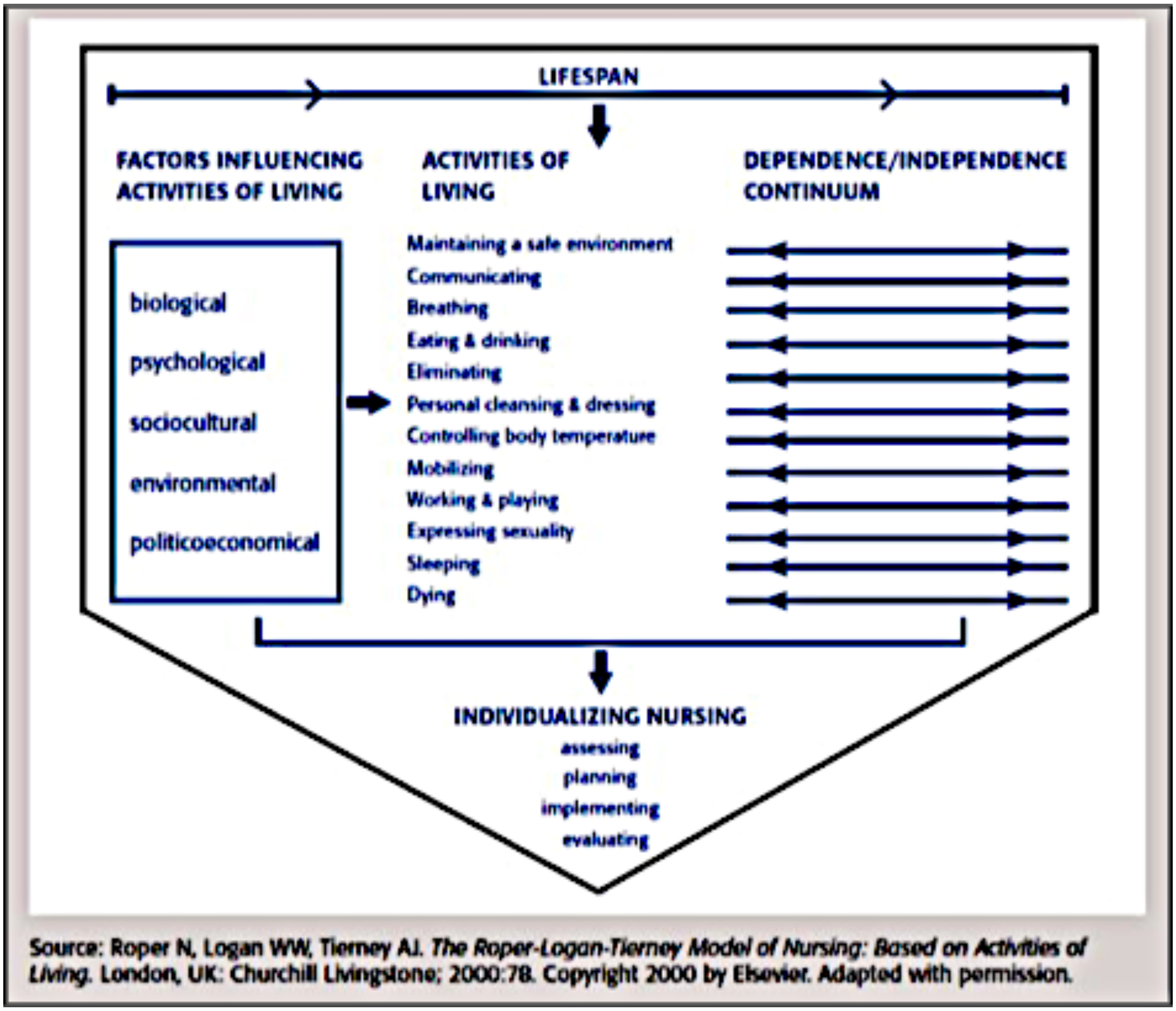

Figure 1. Roger-Logan-Tierney Model of Nursing

The R-L-T Model of Nursing (Figure 1) contains three main portions: factors influencing ADLs, ADLs, and an independence-dependence continuum. All three concepts are connected by an arrow over the model which details the course of a lifespan. According to the model, ADLs can be affected by biological, psychological, sociocultural, environmental, and politicoeconomical factors. The box containing these factors is connected to the list of ADLs with a centralized arrow. The twelve ADLs include maintaining a safe environment, communicating, breathing, eating and drinking, eliminating, personal cleaning and dressing, controlling body temperature, mobilizing, working and playing, expressing sexuality, sleeping, and dying. The list of ADLs is then connected to a collection of bidirectional arrows, which illustrates the independence-dependence continuum. Below the model is a bracket which includes the entire model and states the phases of individualized nursing that include assessing, planning, implementing, and evaluating.

Eating and drinking is included as an ADL in the R-L-T Model of Nursing. The model infers that a patient's ability to independently manage their eating and drinking varies throughout their lifespan. The nurse should assess a patient's baseline eating and drinking patterns and nutritional state with their initial assessment of the patient as well as monitor for changes throughout the patient's illness or recovery period. Nurses should consider factors that can affect changes in a patient's eating habits such as biological factors or those related to their medical illness; psychological factors or those related to their cognitive or emotional state; sociocultural factors or those related to the patient's perceived level of health; environmental factors or the effect of their current environment on their abilities, and politcoeconomic factors such as their ability to afford necessary resources (Roper et al, 2000). The nurse should implement any changes or further referrals based on their initial assessment and then reevaluate the patient's abilities to eat or drink throughout the care of the patient.

This DNP project interfaces well with the R-L-T Model of Nursing as it seeks to address the patient in a holistic manner and include the necessary assessment of a patient's ability to eat and drink, or their nutritional status. As suggested in this model, the nurse should evaluate a patient's ability to eat and drink and any factors that may affect this ADL. In the LT recipient, such influencing factors include the severity of their medical illness, residual cognitive difficulties due to recent episodes of hepatic encephalopathy, their perceived level of nutrition, adjusting to eating and drinking after a major surgery, and their ability to afford recommended dietary supplements. Utilizing a global assessment tool such as the SGA, the nurse can evaluate the LT recipient's nutrition, plan for which individuals may benefit from further evaluation by a trained dietician, and then assist the patient in implementing any recommendations from the dietician.

The R-L-T Model of Nursing could influence future studies by evaluating what specific factors affect the nutritional status of the LT recipient, as well as methods for the nurse to assist the patient in gaining independence in this ADL despite these inhibiting factors. Further studies could also include evaluating other ADLs which may affect both quality of life and overall well being within the LT recipient population, such as their ability to mobilize or sleep after a major surgery and hospitalization.

Statement of Problem

Monitoring a LT recipient's nutritional status throughout the transplant process and the rest of their life is vital in ensuring the best outcomes for the patient. By screening for risk of nutritional deficiency, the healthcare provider can intervene and provide education as well as refer the patient to a dietician for formal assessment and appropriate dietary recommendations. Perhaps due to the lack of gold-standard measurement for nutritional status within the literature for this specific at-risk population, screening in the post-acute LT population is not standardized. Moreover, screening may not be perceived as a priority due the advanced practice nurse being responsible for more acute issues such as monitoring laboratory values to determine graft function, evaluating for signs of rejection, and titrating immunosuppression based on medication troughs.

According to the most recent American Society of Parenteral and Enteral Nutrition recommendations (ASPEN, 2011), all patients are to be screened for nutritional risk followed by a more in-depth nutritional assessment by a trained dietician for those deemed at risk for nutritional deficiency. Although ASPEN recommends this global screening, it is not done in a systematic fashion in the post-acute LT patient population. The SGA is valid and reliable and is considered a gold-standard nutritional screening tool, but has not been used in the post-acute LT population. Further, specific physiologic and hospital course information specific to the post-acute LT patient may add to the usefulness of the SGA in identifying this population's nutritional risk.

Purpose of DNP Project

The purpose of this Doctorate of Nursing Practice (DNP) project was to utilize a Nutritional Assessment Tool (NAT; Appendix C) to screen for nutritional risk in the post-acute LT population, defined as one week or less from hospital discharge after LT. The NAT consists of the SGA screening in addition to data which consists of age, MELD, LOS from LT surgery admission, BMI, and presence of DM at the time of screening. The NAT could potentially be used by the advanced practice nurse as a tool to screen for nutritional risk in post-acute LT patients in the outpatient setting and subsequently refer them for a complete nutritional assessment by a trained dietician.

Specific Aims

In an acute post-LT patient population, the aims of this project were to:

1. Assess nutritional risk using SGA plus additional indicators which consists of age, MELD score, LOS from LT surgery admission, BMI and presence of DM at time of screening.
2. Evaluate dependence of the indicators on the SGA classification (A: well nourished, B: moderately malnourished, C: severely malnourished).
3. Examine the practicality of using a NAT in an outpatient acute post-LT patient clinic visit with an advanced practice nurse as the provider.

CHAPTER II BACKGROUND

End-Stage Liver Disease and Liver Transplant

Data on demographics from donors and recipients as well as patient and graft survival from each organ procurement organization in the US are collected by the Organ Procurement and Transplantation Network (OPTN). The current United Network for Organ Sharing waiting list for an organ transplant including kidney, pancreas, intestine, lung, heart, heart and lung, kidney and pancreas, and liver is over 121,000 (OPTN, 2014). There are 15,730 adults and pediatric candidates are on the United Network of Organ Sharing waiting list for a liver transplant (OPTN, 2014).

The average waiting time varies by patient's MELD score and regional availability. Based on the most recent data set from 2003-2004 (OPTN, 2014), the average wait time for individuals with a MELD <10 is 1,776 days, MELD 11-18 is 639 days, MELD 19-24 is 106 days, and MELD >25 is 20 days. From data collected by OPTN from 1988-2013, over 137,000 individuals have donated liver grafts, and 96% of these came from deceased donors. Of these deceased donors, the cause of death varied. The most prevalent diagnosed causes of death were intracranial hemorrhage and cerebrovascular accident, blunt injury, gunshot wound, cardiovascular injury, and asphyxiation (OPTN, 2014).

Of all adult LT recipients 18 years or older, 52.9% were ages 50-64, and 62.7% of LT recipients of all ages were male (OPTN, 2014). When classified by ethnicity, 72.9% of LT recipients were Caucasian, 12.4% were Hispanic, 9.4% were Black, and 3.9% were Asian (OPTN, 2014). The majority of adult LT recipients (89%) need a LT due to cirrhosis from hepatitis B or C, autoimmune hepatitis, cholestatic disease, or alcoholism (Latifi et al., 2001).

The remainder of adult LT recipients need a LT due to fulminant liver failure, 5-7%; metabolic disease, 4%; malignant neoplasms, 3-6%; biliary atresia, 0.5%; benign masses, 0.5%; and other miscellaneous causes, 1.8-2% (Latifi et al., 2001).

Current data from OPTN (2014) shows that LT recipients have an average survival of 90% at 1 year and 83.3% at 3 years when they have a MELD score of <10; 89.9% survival at 1 year and 83.3% at 3 years for recipients with a MELD 11-18; 87.6% survival at 1 year and 80.7% survival at 3 years for MELD 19-24; and 84.6% survival at 1 year and 76.5% survival at 3 years for MELD >25. Data for five-year survival of these individuals was either not yet collected, or survival rates could not be calculated due to the sample size being too small. Based on recipient age at time of LT, there was a 87.8% survival at 1 year, 79.9% survival at 3 years, and 73.6% survival at 5 years for ages 35-49; 86.1% at 1 year, 76.9% at 3 years, and 70.3% at 5 years for ages 50-65; 86.1% at 1 year, 76.9% at 3 years, and 70.3% at 5 years for ages 50-65; and 81.7% at 1 year, 68.9% at 3 years, and 62.2% at 5 years for ages 65 and older (OPTN, 2014).

Because of the changing nature of our society, LT recipients are becoming more obese. This phenomenon is evidenced by an increase in obesity, defined as BMI greater than thirty kilograms per meters squared, from seventeen to thirty-three percent in the United Network for Organ Sharing LT recipient database from the 1980s to 2000s (Singal, Kamath, Ziller, DiCecco, Shoreibah, Kremers, Charlton, Heimbach, Watt & Shah, 2013), and an estimated one kilogram increase in LT recipient weight per year (Leonard, Heimbach, Malinchoc, Watt, & Charlton, 2008).

In addition to the increased prevalence of obesity in this population, nutritional compromise may also be more prevalent due to recent changes of United Network for Organ

Sharing policy related to liver allocation in the US. The United Network for Organ Sharing enacted Policy 3.6 in October 2013, which changed how liver grafts are allocated regionally. Patients with ESLD and a MELD score greater than or equal to 35 now have priority access to liver grafts within not only their local, but also their regional organ procurement organizations (OPTN, 2013). This policy, also known as Regional Share 35, means that patients with higher MELD scores will receive more graft offers than those with lower MELD scores. Because of this, organizations will be more likely to transplant patients when their MELD score is higher and they are more physically and medically decompensated (Massie, Chow, Wickliffe, Luo, Gentry, Mulligan, & Segev, 2015). Patients who are more debilitated at the time of LT are more likely to have increased time being bed-ridden pre-LT, increased muscle loss and wasting, and a greater nutritional deficiency at the time of LT (Shahid et al, 2005).

Nutritional Deficiency

Nutritional deficiency is often multifactorial in patients with chronic disease and can occur when one or more major nutrients are deficient in the diet. Patients with ESLD are prone to protein deficiency, and developing protein energy malnutrition. This occurs due to the diseased liver using fat as a primary energy source during times of decreased intake such as during sleep, leading to a catabolic state, increased gluoconeogenesis, and muscle wasting (Sanchez & Aranda-Michel, 2006). Patients with ESLD often suffer from nutritional compromise due to increased intestinal protein loss, decreased protein production by the liver, and an impaired ratio of branched-chain and aromatic amino acids (Hasse, 2001; Sanchez & Aranda-Michel, 2006). The alteration of amino acid levels, with low levels of branched-chain amino acids and high levels of aromatic amino acids, leads to high levels of aromatic amino acids in the plasma and crossing the blood brain barrier which causes neurotransmitter competition in the brain, leading to worsening hepatic encephalopathy (Latifi et al., 2001). The shifting in concentration of branched-chain and aromatic amino acids causes decreased clearance of aromatic amino acids in the diseased liver (Latifi et al., 2001). Protein levels are further altered because impaired synthesis in addition to a catabolic state due to cirrhosis is worsened by low protein diets implemented to reduce occurrence of hepatic encephalopathy (Latifi et al., 2001). Hepatic encephalopathy further worsens nutritional status in ESLD because altered mental status decreases the ability to have a sufficient enteral intake safely. Because of the protein alteration occurring as a result of the diseased liver, patients with ESLD often have ascites and associated early satiety. The diseased liver further affects the transition of ribosomes to polysomes leading to further dysfunction in the body through inhibiting the formation of essential proteins (Latifi et al., 2001).

Patients with ESLD also have alterations in carbohydrate metabolism. Due to alterations in carbohydrate metabolism, patients with ESLD are more likely to have decreased production of glucose, glucose intolerance, impaired oxidation of glucose in the periphery, and insulin resistance (Sanchez & Aranda-Michel, 2006; Latifi et al., 2001). Because of this, these patients are more likely to deplete glycogen stores during times of limited intake leading to an "accelerated starvation phenomenon" and increased gluconeogenesis which worsens their nutritional status (Sanchez & Aranda-Michel, 2006). The glycogen stores are thus depleted at a rate of about 10 hours on average in the ESLD patient, compared to 36 hours in the patient with a normal functioning liver (Latifi et al., 2001). This glycogen depletion and "accelerated starvation phenomenon" leads to the catabolic state that occurs with cirrhosis (Latifi et al., 2001; Sanchez

& Aranda-Michel, 2006). This catabolic state is worsened by increased metabolism caused by splanchic hyperemia and impaired hemodynamics associated with a diseased liver (Latifi et al., 2001). Impaired hemodynamics associated with liver disease include a hyperdynamic circulation caused by a decrease in systemic vascular resistance and an increase in cardiac output (Latifi et al, 2001).

Liver disease can also cause distortion to the synthesis of polyunsaturated fatty acids, which can further exacerbate nutritional status (Sanchez & Aranda-Michel, 2006). Increased lipolysis and glycogen depletion caused by the diseased liver leads to prolonged ketogenesis and increased levels of fatty acids in the body (Latifi et al., 2001). As the diseased liver ceases to function, the ability to compensate with ketogenesis is lost (Latifi et al., 2001).

Pre-LT nutritional status can further vary by the disease causing the liver failure. Patients with cholestatic disease such as primary biliary cirrhosis and primary sclerosing cholangitis have malabsorption of vitamins A, D, E, and K, as well as an increased prevalence of celiac disease (Sanchez & Aranda-Michel, 2006). Patients with primary biliary cirrhosis-related ESLD have been found to retain hepatic function the most in comparison to other causes of ESLD, but usually have more muscle wasting (Latifi et al., 2001). Patients who suffer from alcoholic cirrhosis can be severely malnourished with protein and electrolyte deficiencies regardless of whether they are underweight or obese. All diseases causing ESLD can cause zinc deficiency which can lead to impaired protein metabolism as well as distorted senses of taste and smell (Sanchez & Aranda-Michel, 2006).

Patients with ESLD often have anorexia, which has been connected to increased levels of pro-inflammatory cytokines such as tumor necrosis factor and interleukin-1b (Sanchez &

Aranda-Michel, 2006). In addition to these pathological factors, pre-LT nutritional status is also affected by restrictive diets limiting sodium and protein to avoid decompensation such as ascites and hepatic encephalopathy (Hasse, 2001; Latifi et al., 2001).

Nutritional goals for patients with ESLD before LT include preventing further decompensation events, correcting any vitamin deficiencies, reducing further muscle wasting and protein deficiency, and maintaining physical conditioning status (Sanchez & Aranda-Michel, 2006; Hasse, 2001; Latifi et al., 2001). Protein intake should be maintained at 1 g/kg/day initially, and then increased as tolerated based on 24-hour urine nitrogen excretion to a goal of 1.3-2 g/kg/d (Sanchez et Aranda-Michel, 2006).

Nutritional Deficiency Post-Liver Transplant

Because nutritional deficiency is so prevalent in patients with ESLD, LT recipients often undergo a major surgery already compromised. The immediate post-operative period is also marked by continued nutritional deficiency due to delayed graft function. The increased metabolism caused by changes to splanchic, portal, and systemic hemodynamic changes persists for weeks to months after LT (Latifi et al., 2001). Further, glucose utilization continues to be impaired for the first six hours after LT due to delayed mitochondrial redox potential in the liver graft (Latifi et al., 2001). This delayed function forces the liver to continue to use fatty acids instead of glucose to produce adenosine triphosphate until the graft is fully able to utilize glucose (Latifi et al., 2001). Because of this, arterial ketone body ratios can be measured to predict early graft failure after LT. Low-values of arterial ketone body ratios indicate that the graft cannot utilize glucose properly, and that graft failure is likely (Latifi et al., 2001).

Because of the many factors that affect nutritional status post-LT, it is recommended that enteral nutrition should be started twelve hours after LT if possible to reduce overall incidence of surgical complications, reduce infection rates, and improve nitrogen balance (Plauth, Cabre, Riggio, Assis-Camilo, Pirlich, & Kondrup, 2006). In the immediate post-operative period, the LT recipient should also receive 35-45 kilocalories per kilogram per day combined with a protein intake of 1.2-1.5 grams/kilogram/day (Plauth et al., 2006). Current recommendations suggest that a LT recipient will have a negative nitrogen balance until 28 days post LT, and an abnormal protein utilization that persists to at least twelve months post LT (Plauth et al., 1997). Protein intake is suggested at 1-1.5 g/kg/d, with a non-protein energy requirement comparable to other abdominal surgery patients, which can be estimated using the Harris-Benedict Equation (Appendix B) multiplied by an additional thirty percent (Roza & Shizgal, 1984; Plauth et al., 1997).

Nutritional deficiency in the LT recipient is further complicated by the immunosuppressive medications used to stop the body from rejecting the new graft. All immunosuppression medication regimens used after LT impact a recipient's nutritional status, but the direct impact depends on the type, dose, and duration of the medication used. Corticosteroids are typically used in the immediate post-operative period, for the first few months after LT, and if any episodes of rejection occur. Corticosteroids impact nutrition by increasing risk of hypertension, hyperlipidemia, osteoporosis, muscle wasting, peptic ulcer disease, and hyperglycemia (McPartland & Pomposelli, 2007). Further, use of corticosteroids increases protein catabolism in the body leading to a net negative nitrogen balance and an increased need for additional protein intake compared to the general population (Hasse, 2001).

Calcineurin inhibitors such as Tacrolimus and Cyclosporine are commonly used primary immunosuppressive agents that the LT recipient will require for life. Calcineurin inhibitors cause an increased risk of hypertension, hyperlipidemia, hypomagnesemia, hyperkalemia, and de novo DM due to increased insulin resistance (McPartland & Pomposelli, 2007). Secondary agents of immunosuppression such as mycophenolate mofetil and mammalian targets of rapamycin inhibitors can lead to increased prevalence of nausea, vomiting, diarrhea, mouth sores, and elevated triglycerides (McParkland & Pomposelli, 2007). Overall, incidence of de novo hyperlipidemia is 43%, de novo DM is 7-33%, and bone loss occurs at a rate of 1-2% per year in LT recipients as a result of their immunosuppression regimen (Sanchez & Aranda-Michel, 2006). Monitoring these patients' nutrition status is key as obesity and hyperlipidemia are prevalent eighteen-months after LT despite maintaining a recommended caloric intake of the general population (Plauth et al., 1997).

Nutritional deficiency can impact morbidity and mortality of both the patient and the graft post-LT. Poor nutritional status pre-transplant, measured by mid-arm circumference and tricep skinfold thickness (Shahid, Johnson, Nightingale, & Neuberger, 2005) or SGA (Stephenson et al, 2001, Pikul et al 1994) has been associated with longer intensive care unit and hospital LOS (Stephenson et al., 2001, Pikul et al, 1994); increased incidence of infection (Shahid et al., 2005); increased use of various blood products (Stephenson et al., 2001); increased time on a mechanical ventilator and incidence of tracheostomies (Pikul et al, 1994); and delayed graft function (Shahid et al., 2005, Stephenson et al, 2001). Preliminary animal studies have indicated that nutritional therapy provided to the donor individual either through intravenous glucose administration or peri-portal glucose infusion may improve graft function and patient outcomes post-LT (Latifi et al., 2001, Cywes, Greig, & Sanabria, 1992).

Tools to Assess Nutritional Status Post-Liver Transplant

Due to the high prevalence and multifactorial nature of nutritional deficiency post-LT, providers must carefully monitor LT recipients' nutritional status. Obtaining a true nutritional status in this population may be confounded by factors such as fluid retention, diuretic use, and impaired nitrogen balance (Stephenson et al, 2001). Because of this, many typical markers of nutritional status such as weight, BMI, and serum albumin level may be potentially skewed and inaccurate (Barbosa-Silva & Barros, 2006).

The European Society for Clinical Nutrition and Metabolism (2002) suggests that an ideal nutritional screening method consists of a tool that is quick and simple with a high sensitivity which can classify risk of malnutrition and impact of disease process, and determine if further formal nutritional assessment is needed. The SGA is a nutritional screening tool which has shown to be accurate in determining nutritional status in patients with and without chronic disease (Campbell et al, 2007). The tool (Appendix A) was developed by Detsky, McLaughlin, Baker, Johnston, Whittaker, Mendelson, and Jeejeebhoy in 1984 and consists of five subjective questions in addition to presence of certain physical observations. The tool may also include a water test to determine if the patient is safe to swallow, if needed. The screening tool assesses a patient's nutritional history including weight changes in the past two weeks and six months, changes in diet, gastrointestinal symptoms, functional status, and presence of alterations in metabolic demand. The objective portion evaluates the loss of subcutaneous fat, as well as the presence of wasting, edema, and ascites. The provider then scores the responses to the screening tool and the patient is determined to be at risk of being well-nourished (A), moderately malnourished (B), or severely malnourished (C). Patients found to be scored at risk of being moderately or severely malnourished pre-LT have been found to have an increased risk of infection, longer hospital LOS, increased need for post-operative blood transfusion, and longer time spent on a mechanical ventilator (Hasse, 2001). Patients with a moderate (B) or severe (C) malnutrition score on the SGA pre-LT were also found to have a lower hemoglobin and albumin level, higher creatinine, and longer prothrombin time post-LT than patients ranked as well-nourished (A) (Stephenson et al., 2001). The SGA has also been shown to predict outcomes such as increased LOS, increased re-admission rate, and an increased morbidity and mortality rate in the general population (Barbosa-Silva & Barrera, 2006).

The tool was originally created by Detsky et al (1984) to serve as a prognostic tool by screening patients at risk for nutritional deficiency and nutrition associated complications, as such it is not intended for diagnosing malnutrition. Detsky et al (1984) created the tool because objective measures were often confounded by the main disease process of the patient or were slower to respond to changes than subjective measures. The authors found that the SGA was superior in predicting nutritional risk when compared to objective measures such as weight, BMI, albumin, and transferrin (Detsky et al, 1984). The SGA tool was found to have sensitivity of 82% and specificity of 72% in its ability to predict "Nutrition Associated Complications" such as infection, and an inter-rater reliability of 81% in the general population (Detsky et al, 1984). The inter-rater reliability was found to be even higher, at 91%, in patients undergoing abdominal surgery (Detsky et al, 1987) and 94% in pre-LT patients (Pikul et al, 1994). The tool has been widely tested, and found to have convergent validity with other objective measures and predictive validity of complications such as infection and increased LOS (Detsky et al, 1987). The tool uses subjective ranking in its scoring, which accounts for the lower inter-rater reliability (Detsky et al, 1987). The authors suggest that when deciding between two rankings, the scorer should choose to be more specific than sensitive (Detsky et al, 1987). For example, if the scorer is deciding between rankings of A, or well-nourished, and B, risk of being moderately malnourished, the scorer should select A.

The tool is inexpensive when compared to other modalities of measuring nutrition such as laboratory tests, bone density scans, bioimpedance analysis, and indirect calorimetry, and does not require the use of any specialized equipment. SGA is also easy for healthcare providers to utilize in their care as it is simple and does not require the training of a dietician (Barbosa-Silva & Barros, 2006). The SGA screening tool has been studied and utilized in many clinical populations including patients with need for hemodialysis (Jones et al, 2004), general medical patients (Planas et al, 2004), elderly patients (Faxen-Irving et al, 2005), severely ill (Acosta Escribano et al, 2005), cirrhotics (Gottschall et al, 2004), pediatric patients (ASPEN Board of Directors, 2002), oncology patients (Ottery, 1996), patients with colorectal cancer (Gupta et al, 2005), patients with gynecologic cancer (Santoso et al, 2004), orthopedic surgery patients (Murat et al, 2007), patients requiring mechanical ventilation (Sheean et al, 2010), and pre-LT patients (Pikul et al, 1997, Stephenson et al, 2001). The SGA is further suited to be a universal screening tool as its scoring is subjective, with no numeric scale. The authors intended for the practitioner to use subjective weighting to allow for more or less weight to be placed on certain aspects of the screening depending on the patient’s disease (Detsky et al, 1987). This allows for the screening to be modified based on the disease and makes it relevant to use across a variety of clinical populations. These factors support the use of the SGA as an ideal screening tool for any population, including the post-acute LT population, to assist in standardizing the screening process and filling the practice gap.

A modified version of the SGA, the Baylor University Medical Center Revised Subjective Nutritional Assessment Criteria for Adult Liver Transplant Candidates, has been reported as able to assess nutritional risk in the pre-LT population, but is not currently widely used in practice due to lack of studies evaluating validity and reliability as well as poor operational definitions for the screener to utilize the tool (Hasse, Strong, Gorman, and Liepa, 1993).

One limitation of utilizing the SGA to monitor nutritional status in the LT recipient population is the production of categorical data which is more difficult to monitor progression than continuous data such as weight or laboratory values (Plauth et al., 1997). This limitation may also make monitoring the effect of interventions to improve nutritional status more difficult (Pikul et al, 1994). The SGA also relies on the responsiveness of the patient, as well as full disclosure in describing nutritional symptoms and functional capacity. Finally, the SGA is a global screening tool which relies on the screener's discretion, and is thus not an objective measurement. Due to the subjective ranking as intended by the original authors of the tool, inter-rater reliability may be lower than in other screening tools.

Five additional indicators were included in the NAT to determine if any dependence of these indicators exists on the SGA classification. The five indicators selected include age, BMI, LOS from LT surgery admission, MELD at time of transplant, and diagnosis of DM at time of screening. Age, BMI, and DM were selected as older age (Roberts, Angus, Bryce, Valenta, &

Weissfeld, 2004), presence of DM (Blanco, Herrero, Quiroga, Sangro, Gomez-Manero, Pardo, Cienfuegos, & Prieto 2001), and extremes in BMI, whether underweight or obese (Dick, Spitzer, Seifert, Deckert, Carithers, Reyes, Perkins, 2009), have been correlated with increased mortality post-transplant. LOS was selected as the longer the LOS for LT surgery, the increased medical decompensation and physical debilitation can occur. Further, patients who are malnourished are likely to have a prolonged LOS when compared to well-nourished patients (Norman, Pichard, Lochs, & Pirlich, 2008). MELD score at time of LT has also been associated with poorer survival post-LT (Roberts et al, 2004, Shahid et al, 2005)

CHAPTER III METHODS

Specific Aims

In an acute post-LT patient population, the aims of this project were to:

1. Assess nutritional risk using SGA plus additional indicators which consists of age, MELD score, LOS from LT surgery admission, BMI and presence of DM at time of screening.
2. Evaluate dependence of the indicators on the SGA classification (A: well nourished, B: moderately malnourished, C: severely malnourished).
3. Examine the practicality of using a NAT in an outpatient acute post-LT patient clinic visit with an advanced practice nurse as the provider.

Setting

The study was conducted in a transplant institute located in and associated with a large academic medical center in the northeastern US. The surgery program includes islet cell, pancreas, kidney, liver, small bowel, and multi-visceral transplantation to both adult and pediatric patients. Approximately twelve hundred LTs with deceased and living donors have been performed since the start of its program in 1998 (S. Robertazzi, personal communication, March 17, 2015). The adult liver program consists of five hepatologists, three transplant nurse coordinators, six surgeons, one transplant anesthesiologist/critical care physician, one inpatient nurse practitioner (NP), one specialty pharmacist, three outpatient NPs, and a patient services coordinator.

Individuals who are referred as LT candidates are brought to the transplant institute for evaluation based on referral from one of the hepatologists, or from an outside facility. Candidates have a variety of chronic liver conditions, including viral hepatitis B and C, autoimmune hepatitis, alcoholic liver disease, non-alcoholic steatohepatitis and metabolic liver diseases. The candidate is brought to the transplant institute for a LT evaluation clinic appointment where they are seen by a surgeon, hepatologist, social worker, nutritionist, anesthesiologist, research coordinator, and a transplant coordinator. The candidate is provided with education about the process of receiving a LT at the facility, as well as evaluated by the multi-disciplinary team of specialists. The research coordinator meets with the patients to discuss and consent the candidates for any potential clinical research studies which may be applicable to the patient. This multi-disciplinary group then meets once weekly to discuss the evaluations made by the specialists, and their recommendations as to whether to candidate is appropriate to list at that time. If deemed appropriate, the candidate is then listed in the United Network for Organ Sharing database and updated per specified guidelines. The transplant nurse coordinator serves as the candidate's point of contact until they have received their LT.

Once a liver offer is received and deemed suitable for a patient by the surgeon who is on-call, the patient is brought into the hospital for the LT operation. The LT recipient then spends an average of seven days recovering from surgery in a dedicated transplant intensive care unit and nursing floor (S.Robertazzi, personal communication, April 1, 2014). During this time, the surgeon, inpatient NP, specialty pharmacist, and any resident medical staff round on the patient daily and manage their plan of care. The inpatient NP is involved in the discharge planning, and ensures that the LT recipient will follow-up in the outpatient clinic within two to three days of discharge from the hospital.

The LT recipient's care is then transferred to the transplant institute's outpatient clinic, which is also located within the academic medical center. The entire transplant institute uses the outpatient clinic, with certain clinic time dedicated for post-LT recipient appointments. The LT recipient reports one hour before their scheduled clinic appointment to have their blood drawn in the transplant laboratory located within the outpatient clinic. The recipient is then seen by their designated outpatient NP with a clinic appointment allotted one-hour. Three outpatient NPs divide the adult post-LT population, approximately nine hundred patients, alphabetically by the patient's last name. The LT recipient's care is then managed primarily by their outpatient NP for the remainder of their recovery with the consultation of the specified transplant hepatologist or surgeon. The LT recipient is seen in the clinic weekly until their surgical wound is healed, then every other week until they reach their three-month anniversary. The recipient is then seen monthly until their one year anniversary, every six months until their second year anniversary, and then yearly for the rest of their life. The patient is seen in clinic by the outpatient NP and the specialty pharmacist, and the plan of care is discussed with the clinic physician. Any patient issues are discussed in weekly multi-disciplinary conferences, and any relevant imaging or pathology is discussed in weekly hepatobiliary and pathology conferences.

The first three months of visits in the outpatient clinic are focused on wound healing, regaining strength and tolerance, maintaining appropriate hydration and nutritional status, and learning and following strict immunosuppression regimens. After three months, the amount of immunosuppression required is typically significantly less and the focus of the visits transitions to health maintenance. Health maintenance is key as immunosuppression medications lead to an increased risk of obesity, DM, hypertension, and many malignancies. During these visits, the outpatient NP manages the recipient's relevant health maintenance activities such as immunizations, referrals to specialists, and preventative scans such as colonoscopies and bone density scans. The NP also continues to balance the recipient's immunosuppression and liver graft function, as well as maintains surveillance screening exams consisting of abdomen magnetic resonance imaging, chest computed tomography, and alpha-fetoprotein level for any patients with hepatocellular carcinoma on their graft explant based on protocols. Patients who are transplanted for hepatitis C virus receive liver biopsies as needed to evaluate disease recurrence and fibrosis, and can then be initiated on hepatitis C antiviral therapies.

Currently, no specific screening tool for assessing nutritional status or protocol for implementing nutritional interventions is used in this setting. Any needed nutritional interventions are typically determined by a combination of subjective information from patient history, diet recall, weight, and physical exam.

Subjects/Sample

Study participants were recruited at the time of their discharge from the hospital. All liver transplant recipients, from both deceased and living donors, who were greater than 18 years of age were included in the study, so that only pediatric liver transplant recipients were excluded. Participants were recruited during a three-month period from the last week of November 2014 through the end of February 2015. Based on historical data from the transplant institute, three to ten patients were expected to be recruited monthly. The transplant specialty pharmacist approached the study participant at the time of their hospital discharge to ask if they would be interested in participating in this study. If they agreed, the primary investigator (PI) approached the potential participant at their first outpatient clinic visit with further details. If they agreed to participate, a Health Insurance Portability and Accountability Act (HIPAA) and informed consent form were reviewed in detail with the patient and signed at that time.

Procedures

One of two outpatient NPs in the transplant institute delivered the NAT to consented patients at the time of the first outpatient visit. The NAT consists of a collection of indicators, five subjective questions based the patient's history, as well as a brief and focused physical exam. The physical exam consists of evaluating for the presence of ascites, edema, muscle wasting, and any loss of subcutaneous fat. The physical exam requires the examiner to palpate the participant's abdomen, ankles, and upper arms. No invasive procedures are involved in the screening. The screening should take less than fifteen minutes.

Data Analysis

Patient Demographics

Basic demographic data were collected from the electronic medical record including age, gender, ethnicity, and BMI. Transplant-related data such as type of liver disease, MELD score at time of LT, and LOS in days from time of LT until discharge was also collected. Presence of DM, determined by evaluating the patient's diagnosis list in the electronic medical record, at time of first outpatient clinic visit was collected. Laboratory data at the time of the screening was also documented including liver function tests, serum creatinine, and serum albumin levels.

Scoring

Scoring of the SCA screening tool consists of ranking subjective and objective data from which the scorer ranks the patient at risk of being severely malnourished (C), moderately malnourished (B), or well-nourished (A). The length of time used for screening the participant with the NAT will also be collected.

To ensure that the two outpatient NPs scored the SGA portion of the NAT as intended, a one-hour training session, as recommended by Detsky et al (1987), was held before starting data collection. The NPs reviewed educational material on the tool including the scoring guidelines and operational definitions and case examples published by the authors of the SGA (Detsky et al, 1987). At the conclusion of the training session, the outpatient NPs scored three sample patient case studies to seek concurrence. Both NPs ranked all three case studies the same SGA category, so concurrence was achieved.

Practicality

Qualitative data were also collected concerning the practicality of using the NAT in the outpatient clinic of the transplant institute using a short survey (Appendix D). The survey consists of fifteen statements that can be ranked on a scale of 5 with 5 being completely agree, 4 being somewhat agree, 3 being neutral, 2 being somewhat disagree, and 1 being completely disagree. The survey inquired about if the screener felt prepared to administer the tool as well as the clarity of the directions, questions, and scoring. The survey also included feedback on the utilization of this tool in the flow of the clinic visit, the applicability to the patient population, appropriateness of the length of tool, and the timing of the screening at the first post-operative outpatient visit. Any difficulties in performing the screening or in the patient understanding the screening questions were collected. Buy-in and support of the screening tool from the outpatient NPs was evaluated. Finally, there was a section for the screener to discuss their concerns, comments, suggestions, and questions about the tool.

Statistical Analysis

MATLAB R2014b was used to perform the statistical analysis for this DNP project. For Aim 1, descriptive statistics including mean and standard deviation were used to describe demographic data, lab values, and additional indicators. For Aim 2, evaluating dependence of the five additional indicators on the SGA classification, two statistical tests were used. The indicators of age, BMI, MELD score, and LOS are continuous variables, so an ANOVA was used to compare these indicators to SGA category. The indicator DM is a categorical variable, so a Fischer's exact test was used to compare DM diagnosis (yes or no) to SGA category, well-nourished (A) or malnourished (B or C). A $p \leqq 0.05$ was considered statistically significant for all comparisons. For Aim 3, determining practicality, mean and standard deviation of time was determined.

Human Subjects

Approval from the International Review Board (IRB) at both the University of Arizona and the university associated with the transplant institute was obtained before initiating the study, with the university associated with the transplant institute serving as the IRB of record. HIPAA and informed consents were obtained before each participant was enrolled in the study. Human subject involvement was limited to the use of the tool in those who consented and determination of practicality of its use by the outpatient NPs. The study data were not used for any decision making concerning treatment or plan of care for the LT recipient.

CHAPTER IV RESULTS

Description of Sample

Based on historical data, the expected recruitment was twenty participants. Over a period of three months, eighteen participants were recruited for the study and seventeen were consented and enrolled. Only one potential subject declined to participate in the study when approached by the PI at the first clinic visit.

The main recruitment fallout occurred because several potential participants had a LT during but were still hospitalized at the end of the recruitment period due to longer than anticipated LOS. This occurred due to the organization transplanting patients with higher MELD scores due to the Regional Share 35 policy enactment, which was initiated in October 2013. Patients transplanted with higher MELD scores are more physically and medically decompensated at the time of LT (Shahid et al, 2005), and thus require longer LOS to deal with various complicating factors. The relatively short recruitment period may have skewed the data by excluding potential participants with longer LOS.

The sample (Table 1) consisted of seventeen participants ranging from twenty-three to seventy-two years of age. The predominant ethnicity, accounting for over fifty percent of the sample, was Caucasian, followed by African American and Hispanic. The majority of participants (12/17) were men.

TABLE 1. *Description of Sample*

Category	N (%)
Total Participants	17
Age	
20-40 years	5 (29.4%)
40-60 years	8 (47.1%)
60+ years	4 (23.6%)
Gender (Man/Woman)	12/5
Ethnicity	
Caucasian	10 (58.8%)
African American	6 (35.3%)
Hispanic	1 (5.9%)
Type of Transplant	
Deceased Donor	14 (82.4%)
Living Donor	3 (17.6%)
Indication for Transplant	
HCV	6 (35.3%)
PSC	5 (29.4%)
ETOH	4 (23.5%)
Other	2 (11.8%)

HCV: hepatitis C cirrhosis; PSC: primary sclerosing cholangitis; ETOH: alcoholic cirrhosis

The most frequent types of liver disease represented in the sample were hepatitis C cirrhosis (6/17) followed by primary sclerosing cholangitis (5/17) and alcoholic cirrhosis (4/17).

Two unusual causes of liver disease within the sample included carcinoid tumor and fulminant drug-induced liver injury related to an anti-viral agent for Human Immunodeficiency Virus. The liver disease of seven participants was also complicated by the diagnosis of hepatocellular carcinoma. Although the majority of participants had a deceased donor liver transplant, three participants had a living donor liver transplant. These three cases involved a domino transplant in which a pediatric patient received a deceased donor graft for a metabolic condition, maple syrup urine disease, and then the pediatric graft was placed into an adult recipient.

Laboratory data collected on each participant included aspartate aminotransferase (AST), alanine transferase (ALT), alkaline phosphatase (ALP), total bilirubin, serum creatinine, and serum albumin levels (Table 2). In this sample, the mean value for each category of laboratory data was considered abnormal, but commensurate with their diagnosis of recovering from liver failure. The mean value for AST was just above the upper level of normal; whereas, the mean value for ALT and ALP was over double the upper limit of the normal range. For AST and ALT, the standard deviations, 42.2 and 118.5 IU/mL respectively, were similar to the values of the means, 41.1 and 114.1 IU/mL, demonstrating the wide variance in liver function across the sample. Serum albumin was below the lower limit of the normal range. Total bilirubin and serum creatinine levels were just at or above the upper limits of the normal range.

Table 2. *Laboratory Values*

Lab Value	Mean ± Standard Deviation	Normal Range
AST	41.1± 42.2 IU/L	10-40 IU/L
ALT	114.1 ± 118.5 IU/L	7-56 IU/L
ALP	238.8 ± 162.3 IU/L	44-147 IU/L
Total Bilirubin	1.3 ± 0.9 mg/Dl	0.3-1.9 mg/dL
Serum Creatinine	1.3 ± 0.9 mg/dL	0.7-1.3 mg/dL
Serum Albumin	3.1 ± 0.5 g/dL	3.4-5.4 g/Dl

AST: aspartate aminotransferase; ALT: alanine aminotransferase; ALP: alkaline phosphatase

Aim 1: Assessing Nutritional Risk

SGA Results

The NPs scored the SGA in accordance with the guidelines established by the original authors of the tool (Detsky et al, 1987). Out of the seventeen participants, the majority, 70.5%, were given a ranking of A, or well-nourished, on the SGA and 23.5% of the participants were ranked as B, or moderately malnourished (Table 3). Only one participant (5.9%) was given a ranking of C, or severely malnourished.

Table 3. *SGA Results*

SGA Score	Number of Participants	Percentage
A	12	70.5
B	4	23.5
C	1	5.9

SGA: Subjective Global Assessment

Additional Indicators

The average age of the sample was 50 years (Table 4). The average BMI was 27 kilograms per meters squared, which is considered overweight. The average LOS was eleven days. Only two participants were diagnosed with DM at the time of screening. Finally, the MELD score was approximately twenty. Many of the participants (52.9%) were transplanted at a higher MELD score than is demonstrated by this value as they benefitted from exception points granted by the United Network for Organ Sharing for reasons such as hepatocellular carcinoma within Milan criteria or multiple episodes of cholangitis.

When grouped by SGA category (Table 5), the mean age was 51 years for all well-nourished participants (A) and 45 years for all malnourished patients (B or C). The average LOS was approximately eleven days for both groups. The average MELD score was 17 for the well-nourished group (A) and 27 for the malnourished group (B or C). The average BMI of the well-nourished group (A) was slightly higher, 28.5 kilograms per meters squared, when compared to the BMI of the malnourished group (B or C), 24.3 kilograms per meters squared. Both patients with diagnosed DM were well-nourished (A).

Table 4. *Additional Indicators*

Indicator	Mean ± Standard Deviation
Age	50 ± 15 years
Length of Stay	11.4 ± 4.2 days
MELD score	20.3 ± 11.4
BMI	27.3 ± 8.7 kg/m^2
DM (no/yes)	15/2

MELD: Model for End-Stage Liver Disease; BMI: body mass index; DM: diabetes mellitus

Table 5. *Additional Indicators by SGA Category*

	Mean ± Standard Deviation	
Indicator	**Well-Nourished (A)**	**Malnourished (B or C)**
Age	51.9±14.1 years	45.4±17.6 years
Length of Stay	11.5±4.5 days	11.2±3.6 days
MELD score	17.5±11.1	27±10.3
BMI	28.5±8.9 kg/m^2	24.3±8.4 kg/m^2
DM (no/yes)	10/2	5/0

MELD: Model for End-Stage Liver Disease; BMI: body mass index; SGA: Subjective Global Assessment; DM: diabetes mellitus

Aim 2: Dependence of Indicators on SGA Classification

An ANOVA was used to evaluate for any dependence of the four continuous variable indicators on the SGA classification, which consists of well-nourished (A), moderately malnourished (B), and severely malnourished (C) (Table 6). No statistically significant dependence of any of the indicators (age, MELD, LOS, and BMI) was found on the SGA classification.

Table 6. *Dependence of Continuous Indicators (Age, BMI, LOS, MELD) on SGA Classification Using ANOVA*

Indicator	**Sum of Squares**	**Degrees of Freedom**	**Mean Squares**	**F test**	**p value**
Age	777.1	2	388.5	1.9	0.2
BMI	216.9	2	108.4	1.5	0.3
LOS	6.4	2	3.2	0.2	0.9
MELD	443.5	2	221.8	1.9	0.2

SGA: Subjective Global Assessment; BMI: Body Mass Index; LOS: Length of Stay; MELD: Model for End-Stage Liver Disease; ANOVA: Analysis of Variance

A Fischer's exact test was used to evaluate the dependence of the presence of DM on the SGA classification (Table 7). The presence of DM (yes or no) was compared to SGA classification of well-nourished (A) or malnourished (B or C). No statistically significant dependence of the presence of diagnosed DM was found on the SGA classification.

Table 7. *Dependence of DM Diagnosis on SGA Classification Using Fischer's Exact Test*

	SGA score		
DM	**A**	**B, C**	**Column Total**
Yes	5	10	15
No	0	2	2
Row Total	5	12	17
χ^2= 0.9; p= 0.3			

DM: diabetes mellitus; SGA: Subjective Global Assessment

Aim 3: Practicality

The average time for the outpatient NP to administer the NAT was 9.7 +/- 2.4 minutes. A survey was administered to the two outpatient NPs who participated in the study, one of whom was the PI, to evaluate practicality of the NAT. In general, both NPs agreed that the NAT was easy to administer and appropriate to use at the first post-operative clinic visit. Neither NP felt that the NAT took too much time away from a clinic visit or was missing key information necessary to evaluate nutritional status. The PI felt that the directions and scoring of the NAT could be clearer. Both NPs agreed that the questions were clear enough for patients to understand and answer appropriately. No additional comments or concerns were listed at the bottom of the practicality survey.

CHAPTER V DISCUSSION

ESLD and decompensated cirrhosis are prevalent in the US and account for the 12th leading cause of death (CDC, 2013). LT is thus a vital life-saving surgical option for patients with ESLD. Although nutritional deficiency is known to be both common and multifactorial in this population, a global systematic method of evaluating nutritional status has not been widely implemented. The purpose of this DNP project was to assess nutritional risk in the post-acute LT population using SGA and additional indicators.

Assessing Nutritional Risk

The demographics of this sample (Table 1) were representative of LT recipients across the US, demonstrated by recent data from the Organ Procurement and Transplantation Network (OPTN, 2014). The vast majority of participants in this sample were men, which is about 10% higher than that reported by OPTN (2014). Similar to OPTN (2014) data on LT recipients in the US, the predominant ethnicity was Caucasian in this sample, and the primary indication for LT was hepatitis C cirrhosis.

The three participants who received a domino LT graft from an individual with maple syrup urine disorder will require frequent monitoring of branched-chain amino acids (leucine, isoleucine, and valine) during the initial post-transplant period. The domino transplant is a relatively unique surgical option for this condition; however, the nutritional status of these recipients should be similar to that of other LT recipients as their branched-chain amino acid levels should remain normal or near-normal (Khanna, Hart, Nyhan, Hassanein, Panyard-Davis, & Barshop, 2006; Popescu & Dima, 2012; Badell, Hanish, Hughes, Hewitt, Chung, Spivey, & Knechtle, 2013).

Laboratory data collected on each participant was abnormal, which is consistent with the diagnosis of chronic liver disease. All liver function tests were above normal range (Table 2). The variance in values of AST and ALT are not unexpected in this population due to resolving liver failure. The cause of such variance is likely multifactorial, including LOS for the participant, as those discharged from the hospital earlier are likely to still have recovering liver function and subsequent transaminitis, as well as variance in both graft function and quality for each participant. The mean albumin level of the sample, not just the participants ranked as malnourished, was also below normal range which demonstrates that utilizing this marker in the post-acute LT population is confounded by the recovery of liver function (Barbosa-Silva & Barros, 2006; Sanchez & Aranda-Michel, 2006; Hasse, 2001). No statistical evidence for correlation was found between albumin and AST (r=0.01) or albumin and ALT (r=0.08). When stratified by SGA category, no statistical correlation between albumin and AST of participants ranked as well-nourished (r= -0.15), albumin and AST of participants ranked as malnourished, designated by a B or C ranking, (r=0.22), albumin and ALT of participants ranked as well-nourished (r= -0.02), or albumin and ALT of participants ranked as malnourished (r=0.15).

The widely validated SGA was used to screen the nutritional risk of seventeen post-acute LT participants. The authors of the SGA, Detsky et al (1987), reported that 69% of their sample of 202 pre-major gastrointestinal surgery patients ranked as well-nourished (A), 21% as moderately malnourished (B), and 10% as severely malnourished (C). Remarkably similar to the data in pre-major surgery gastrointestinal surgery patients by Detsky et al (1987), we found that 70.5%, 23.5% and 5.9% were well-nourished, moderately malnourished, and severely malnourished, respectively (Table 3). This finding demonstrates for the first time that when the

SGA is used as originally described by Detsky et al (1987), nutritional status in the post-acute LT population can be measured. Further, the nutritional status of the post-acute LT population may be similar to other chronic illness conditions known to affect nutrition.

These findings indicate that while the majority of participants were ranked as well-nourished in this sample, almost 30% of patients were at risk of being moderately malnourished; and 6% were at risk of being severely malnourished. This marks an important implication for practice, as the advance practice nurse has the opportunity to improve the nutritional status of a significant percentage of the post-acute LT population through careful screening and referral to a trained dietician. The SGA tool can serve as a valuable screening tool for this at-risk clinical population.

Five indicators were included on the NAT in addition to the SGA to determine if any dependence was present on the SGA classification (Table 4). The five indicators included age, BMI, presence of diagnosed DM at time of screening, MELD at time of LT, and LOS from the LT onward. Three indicators, age, BMI, and DM were selected as they are characteristics typically associated with nutritional risk in the general population. LOS was selected because a worse nutritional risk as ranked by SGA has been connected to a longer LOS (Stephensone et al, 2001). Finally, MELD was selected because individuals with the highest MELD score are generally considered the most medically ill, thus likely leading to an increased nutritional risk (Shahid et al, 2005).

The average age of the sample was fifty years, which is comparable to OPTN (2014) data, which revealed 52.9% of adult LT recipients were between 50-64 years of age. The average BMI of the sample was 27.3 kilograms per meters squared, which is considered overweight. This is consistent with the trend discussed by Singal et al (2013) who reported that LT recipients are becoming increasingly obese with each decade since 1980, similar to that of the general population. Only two participants had DM at the time of screening. This will likely increase as the length of immunosuppression therapy increases, as the rate of de novo DM with these agents, especially calcineurin inhibitors and corticosteroids, is considerable (McPartland & Pomposelli, 2007, Hasse, 2001).

The average MELD was approximately twenty. This may under represent the acuity level of the sample, as this study did not include United Network for Organ Sharing granted exception points. About half of the participants were transplanted with exception points granted by the United Network for Organ Sharing. Of note, other studies that measured nutritional status and included MELD score as a data point also did not include exception points (Shahid et al, 2005). Further, patients with higher MELD scores were not necessarily captured in this sample due to their extended LOS past the recruitment period of this study. Extending the recruitment period would have allowed for a more representative sample of patients who are transplanted at higher MELD scores and may require significantly longer LOS due to medical and physical decompensation. Although the average LOS for the transplant institute is historically seven days, the average LOS found in this sample was higher at eleven days. Capturing the LOS for the entire admission that includes the LT, not just from the LT onward, could have revealed more information concerning the decompensation of the participant. Prolonged LOS in the post-LT population has been associated with higher complication rates, such as infection and renal failure, and overall reduction in one-year patient and graft survival (Smith, Shiffman, Behnke, Stravitz, Luketic, Sanyal, Heuman, Fisher, Cotterel, Maluf, Posner, & Sterling, 2009).

When divided by SGA score (Table 5), the mean BMI of the well-nourished group (A) was higher than the malnourished group (B or C). Further, the mean BMI of the well-nourished group was considered overweight (28.5 kilograms per meters squared), while the mean BMI of the malnourished group was within normal BMI range (24.3 kilograms per meters squared). Patients at either extreme of BMI, underweight or obese, have been associated with worse nutritional status (Dick et al, 2009). The mean age of the malnourished group (B or C) was approximately five years younger than the mean age of the well-nourished group (A). This differs from results of Roberts et al (2004) who connected older age with worse nutritional status. The mean MELD of the well-nourished group (A) was notably lower at 17.5 than the malnourished group (B or C) at 27. This is consistent with results from Shahid et al (2005) which connected a higher MELD score with a worse nutritional status. The mean length of stay for both groups, well-nourished and malnourished, was the same at approximately eleven days.

Collecting the five additional indicators in addition to the SGA as part of the NAT was intended to better define the participant and make the tool more specific to LT recipients. Although these factors should not be considered in the scoring of the SGA and ranking of nutritional risk, their inclusion may be important when considering the entirety of the patient and who may need further evaluation by a dietician. For example, an individual may be ranked as moderately malnourished according to the SGA but may also have a high MELD score and prolonged LOS. The advanced practice nurse should consider all of these factors, as this patient may benefit from further evaluation by the dietician due to these extenuating factors. It is important to note that further research on a larger scale is warranted to further classify the importance of these indicators in the post-acute LT population's nutritional risk status.

Dependence of Indicators on SGA Classification

When evaluating the dependence of the additional indicators of age, BMI, MELD score, LOS for LT surgery, and diagnosis of DM at time of screening on the SGA classification, no statistically significant dependence was found (Table 6 & 7). This is expected due to the small sample size and not calculating power due to the nature of this DNP practicality project.

Further valuable information discerning if any dependence of the indicators on the SGA classification exists in this post-acute LT population could be gained by performing a further study in which an appropriately powered sample size was used. This would allow for more robust data to be collected concerning what characteristics may be found in the group of participants with worse scores on the SGA. In this sample, only one participant was ranked as C, or risk for being severely malnourished. Although treatment decisions were not made using the information gleaned from this NAT assessment, this patient was promptly referred to a dietician based on clinician assessment for further evaluation and recommendations.

If the SGA was implemented as part of an evidence-based practice protocol within the outpatient clinic in this setting, any patient who is scored as being at risk of being moderately malnourished (B) or severely malnourished (C) should be referred to a trained dietician for further assessment. Once the dietician's assessment is complete, the advanced practice nurse can then assist the patient in maintaining appropriate recommendations, such as prescribing recommended nutritional supplements, and providing reassessment of nutritional status using SGA at frequent intervals, perhaps monthly until a well-nourished status (A) can be achieved. Guidelines from the European Society for Clinical Nutrition and Metabolism suggest that the care team should monitor for effectiveness of nutritional outcomes with rescreening using the original assessment tool in addition to body weight and any side effects of nutritional interventions, but does not suggest a certain frequency of reassessment (Kondrup, Allison, Elia, Vellas, & Plauth, 2003). Further, this process of assessing, planning, implementing, and evaluating aligns well with the nursing process defined in the R-L-T Model of Nursing (Roper et al, 2000).

Practicality

The ideal characteristics of a global nutritional screening tool are that the tool is simple and quick with a high sensitivity, and can classify nutritional risk in order to determine the need for further evaluation by a trained dietician (ESPEN, 2002). The SGA has been widely tested in many populations including both general surgery and liver disease populations, and shows convergent validity with other measures of nutritional risk and a sensitivity of over eighty percent in predicting nutrition-associated complications (Detsky et al, 1984). The NAT was performed in an average of approximately ten minutes, which places minimal time burden on the outpatient visit, allotted one hour in the setting where this study was carried out. The tool was also simple in that it did not require special equipment or the training of a dietician (Detsky et al, 1984). The only training involved was a one-hour session to review operational definitions and guidelines as well as seek concurrence between the scorers before starting to administer this tool. The only cost associated with using this tool was a one-time purchase, totaling less than ten dollars, of rights to reproduce and use the SGA.

No additional comments or feedback were found on the practicality surveys provided to the two outpatient NPs. Both NPs agreed that they would use this tool in their practice, and that it was applicable to both the post-acute LT population and at the first outpatient clinic visit. Both

NPs also agreed that they felt prepared to administer the tool and that it was quick and easy enough to utilize during an outpatient clinic visit. Some critiques provided by the PI included that both the scoring and directions of the screening tool could be more clear. The PI felt that the operational definitions, case examples, and guidelines found in the Detsky et al (1987) article helped significantly in clarifying both the directions and scoring of the SGA. A brief summary of these directions, such as definitions of loss of muscle and fat, was included in the NAT for ease of administering the tool as intended by the authors of the SGA.

Overall, based on the practicality survey as well as the minimal time burden, the NAT appears to be practical for use by the advance practice nurse within the post-acute LT population in this transplant institute. Further research is warranted to determine if this can be generalized outside of this specific setting.

Limitations

A limitation of this study was the small, non-probability convenience sample drawn from a single center. This DNP project was primarily a practicality study conducted over a short period of time, and the overall purpose was to determine if the SGA could be utilized by advance practice nurses in an outpatient clinic to evaluate nutritional risk of the post-acute LT population. Additional data were collected to help understand if various physiologic and hospital course data were different amongst various levels of nutritional risk. The recruitment period of three months was also relatively short which further limited both the sample size as well as the ability to capture potential participants with LOS longer than the recruitment period. This may have caused potential participants with higher MELD scores to not be included in the sample, thus decreasing its variability and skewing the data. Because of these factors, the generalizability of this study is limited, thus reducing its external validity.

Another limitation of this study was that only two advance practice nurses, one of whom was the PI, participated in utilizing the NAT and providing feedback via the practicality survey. This limits the feedback that could be obtained concerning the buy-in as well as any critiques of the tool as well as leads to potential bias because the PI was included in the survey process.

The SGA is limited due to its reliance on the participant's responsiveness and accuracy in recall which was first acknowledged by Detsky et al (1984). Despite this, the SGA has been found to be reliable and valid when studied in many patient populations, including the post-acute LT population in this setting.

Future Steps

This DNP project did contribute to knowledge concerning the assessment of nutritional risk within the post-acute LT population in this setting. The utilization of this NAT proved to be a quick and easy global risk assessment performed by two advanced practice nurses in an outpatient clinic setting. The PI felt that this would be a valuable addition to clinical practice as it encouraged prodding into a patient's nutritional history in order to supplement the physical exam and basic history in order to better capture those individuals who may benefit from further evaluation by a trained dietician. Because only one dietician exists for the entire liver population, both pre and post-transplant, in this transplant institute, the decision of which patients can benefit from further assessment is vital.

At this time, the SGA could be implemented into practice in this outpatient clinic to assess nutritional status in the post-acute LT population. If further studies were done validating the use of one or all of the additional indicators in predicting nutritional risk in this population, these additional indicators are included in the electronic medical record and could be easily accessed for consideration by the advanced practice nurse.

Looking forward, the data and knowledge produced by this DNP project could be supplemented by further studies. This study could be improved by extending the recruitment period past three months to allow for those with longer LOS and/or higher MELD scores to be included to better describe the decompensation level of the patient. Practicality could be further evaluated by including more advanced practice nurses within one center or expanding the study to multiple centers that use advance practice nurses to care for the post-acute LT population. Further, if studies were performed on a larger scale, feasibility as well as content validity could be explored.

Future studies could include evaluating if a worse nutritional risk status as evaluated by SGA in the post-acute LT population did suggest worse outcomes such as higher readmission and complication rates as the original authors of the SGA intended it to serve as a prognostic tool of nutrition-associated complications (Detsky et al, 1984).

Further study is warranted to determine the significance of including the additional population-specific indicators in the NAT as well as the generalizability of the findings of this DNP project outside of this setting.

Conclusion

Monitoring nutritional status in the post-acute LT population is vital as poor nutritional status can affect recovery, morbidity and mortality, and quality of life for these patients. Because nutritional deficiency is known to be multifactorial and prevalent in this population, it is essential for the provider to assess nutritional risk and provide appropriate referral to a trained dietitian for further evaluation. Implementing a NAT, or the SGA at minimum, in the post-acute LT population in this setting served to be a practical method of assessing global nutritional risk.

APPENDIX A

SUBJECTIVE GLOBAL ASSESSMENT

Appendix A. Subjective Global Assessment

Subjective Global Assessment Form

Patient Name:____________________ Patient ID: _______________ Date: _________

Medical History

Weight Change

Weight	_______ kg	Height	______ cm		
Weight loss over the past 6 months				No ☐	Yes ☐
Weight loss (if known)	______ kg	______ %			
Weight change over the past 2 weeks			Gain ☐	No loss ☐	Continued Loss ☐
Weight change (if known)	______ kg	______ %			

Diet Change	Normal intake ☐	Reduced intake ☐	Semisolid or liquid diet ☐	Very poor intake or starvation ☐

Gastrointestinal Symptoms (persisting for > 2 weeks)

Pain on eating	No ☐	Yes ☐	Severe ☐
Nausea	No ☐	Yes ☐	Severe ☐
Vomiting	No ☐	Yes ☐	Severe ☐
Diarrhea	No ☐	Yes ☐	Severe ☐

Functional Capacity	Normal ☐	Reduced capacity ☐	Unable to work ☐	Ambulatory ☐	Bed ridden ☐

Physical Examination

Loss of body fat	No ☐	Yes ☐	Severe ☐
Loss of muscle mass	No ☐	Yes ☐	Severe ☐
Presence of edema	No ☐	Yes ☐	Severe ☐
Presence of ascites	No ☐	Yes ☐	Severe ☐

SGA Rating

A ☐	**B** ☐	**C** ☐
Well- nourished	Mildly / Moderately malnourished	Severely malnourished
Normal	Some features of progressive nutritional loss	Evidence of wasting and progressive symptoms

APPENDIX B

HARRIS-BENEDICT EQUATION

Appendix B. Harris-Benedict Equation

For men: Basal Energy Expenditure (BEE) = 88.362 + (13.397 x weight in kg) + (4.799 x height in cm) - (5.677 x age in years)

For women: BEE = 447.593 + (9.247 x weight in kg) + (3.098 x height in cm) - (4.330 x age in years)

Post-LT recovery: Daily Kilocalorie Requirement=BEE*.30

Roza & Shizgal (1984).

APPENDIX C

NUTRITIONAL ASSESSMENT TOOL

Appendix C. Nutritional Assessment Tool

1. Screener instructions per original operational definitions

A. Loss of subcutaneous fat is to be measured in the tricep region at the mid-axillary line at the level of the lower ribs.
B. Muscle wasting is to be measured by palpation of loss of bulk at quadriceps and deltoid regions.
C. Edema is to be measured by presence of ankle and/or sacral swelling.
D. The authors intend for subjective scoring to be used by the screener to best match their clinical judgment of the status of the individual patient.

II. Indicators

Age at time of transplant _____

MELD score at time of transplant ______

LOS of admission for transplant _____

Presence of DM at time of screening YES/NO

BMI at time of screening _____

Time in minutes to administer this screening including data collection _____

III. SGA (Appendix A)

SGA and operational definitions used with permission. Originally published Detsky et al (1984) with scoring guidelines and operational definitions from Detsky et al (1987).

APPENDIX D

PRACTICALITY OF USING NAT IN POST-ACUTE LT POPULATION SURVEY

Appendix D. Practicality of Using NAT in Post-Acute LT Population Survey

Rate the following statements on a scale of 1 to 5, with 1 being strongly disagree, 2 being somewhat disagree, 3 being neutral, 4 being somewhat agree, and 5 being strongly agree.

1. I was prepared to administer this tool to my adult post-liver transplant patients.
1 2 3 4 5

2. I felt that I needed additional training in order to administer and score this screening tool.
1 2 3 4 5

3. I felt the questions in the screening tool were clear and direct.
1 2 3 4 5

4. I felt the directions of the screening tool were clear and direct.
1 2 3 4 5

5. I felt that the questions were clear enough for patients to readily understand and answer appropriately.
1 2 3 4 5

6. I agreed with the content of the screening tool.
1 2 3 4 5

7. The questions of the screening tool were applicable to the adult post-liver transplant patient population.
1 2 3 4 5

8. I felt that the tool was easy to administer during an outpatient clinic visit.
1 2 3 4 5

9. I felt that the tool was appropriate to administer at the first post-transplant outpatient clinic visit.
1 2 3 4 5

10. I felt that this screening tool took too much time away from the clinic visit.
1 2 3 4 5

11. I felt that the scoring of the tool was clear and direct.
1 2 3 4 5

12. I felt that this screening tool added benefit to my assessment of an adult post-liver transplant patient's nutritional status.

1 2 3 4 5

13. I felt that this screening tool was missing information needed to assess my patient's nutritional status.

1 2 3 4 5

14. I would consider using this tool in my clinical practice.

1 2 3 4 5

15. I would recommend this tool to others in my field.

1 2 3 4 5

Please use the space below to provide any additional comments, concerns, suggestions, or feedback you have on the use of the screening tool. Please also list any questions that you or your patients had about the tool.

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