Nutritional Implications of Liver Transplantation

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Malnutrition is a common problem of patients undergoing liver transplantation. To treat malnutrition, it must first be identified through a nutritional assessment. Because many objective nutritional assessment parameters have limitations in end-stage liver disease, subjective nutritional indicators may be used as an alternative. Nutritional needs following transplantation are categorized as short and long term. The short-term nutritional goal, anabolism, can be complicated by the nutritional status of the patient, surgical procedures, and necessary medications. The increased nutrient needs during the early posttransplant phase require particular nutritional support. Nutrition-related problems following transplantation may include obesity, hyperlipidemia, hypertension, diabetes mellitus, hyperkalemia, edema, or osteoporosis. Dietetic advice relative to the nutritional needs of the liver transplant recipient can improve both the short- and long-term outcomes. (Henry Ford Hosp Med J 1990;38:235-40)

Liver transplantation has become a therapeutic option for hundreds of victims of hepatic failure each year (1-3). Improved survival rates of liver transplant recipients in the past decade are due to many factors including improved surgical techniques and methods of organ preservation, better selection criteria for recipients, advances in understanding of the immune system, introduction of new immunosuppressive agents, and increased knowledge in the prevention and management of potentially fatal complications (1,4-8).

Debility, malnutrition, encephalopathy, and massive ascites, conditions associated with end-stage liver disease (ESLD), continue to be risk factors in transplantation (1). Accordingly, treatment of these conditions, which is largely dependent on proper attention to nutrition, improves the probability of successful transplantation (7,9-12).

Nutritional Assessment of the Liver Transplant Candidate

In order to treat nutritional abnormalities and malnutrition, they must first be identified. The task of the dietitian working with liver transplant patients is to complete the nutritional assessment which, at Baylor University Medical Center (BUMC), occurs during the initial evaluation of a patient’s suitability for liver transplant. Determining the nutritional status of a pretransplant patient may be hampered by the effect of the liver disease on the usual parameters of objective nutritional assessment. These include body weight, anthropometric measurements, urinary creatinine and 3-methylhistidine excretion, nitrogen balance, serum visceral protein levels, tests of delayed hypersensitivity, and the total lymphocyte count (TLC) (9,10,13-16).

Objective nutritional assessment parameters

The most commonly used nutritional assessment parameter is body weight. However, weight measurement may not be a valid nutritional index in patients with ESLD because edema, ascites, and administration of diuretics alter body weight (9,10,13). Loss of lean body mass in a pretransplant patient may be masked by concurrent fluid retention when body weight is used as the nutritional indicator.

Anthropometric measurements (tricep skinfold and arm muscle circumference) have been proposed as more accurate than body weight as markers of nutritional status in pretransplant patients (10,15). Malnutrition, aging, decreased body mass, and suboptimal protein intake all can be altered in ESLD and will affect CHI values (13,16). The hepatorenal syndrome occurs with some
frequency in the pretransplant population and also alters CHI (13,14). The required 24-hour urine specimens are difficult to collect. In addition, levels of creatinine, a metabolite of creatine which is synthesized in the liver (19), are likely to be abnormal and cause an erroneous CHI measurement.

Nitrogen balance studies, like CHI studies, require 24-hour urine collections as well as concurrent records of protein intake. Both are difficult to obtain unless subjects are maintained in a controlled environment. The hepatorenal syndrome, which is fairly common in patients with ESLD, leads to nitrogen retention in the forms of BUN and ammonia. Consequently, nitrogen excretion is decreased, making a true nitrogen balance study unrealistic (9,13,20).

Three-methylhistidine in urine is a biochemical marker used to estimate protein stores. Mean 3-methylhistidine values were normal in a study of 74 pre-liver transplant patients, although reduced muscle mass affected the levels (16). Renal function, age, sex, dietary intake, trauma, and infection also affect 3-methylhistidine excretion (21).

Protein status is often estimated from measurements of serum levels of albumin, transferrin, prealbumin, and retinol-binding protein whose levels are commonly depressed in liver failure (9,10,13,15,16,22). Levels of these serum proteins are affected by the state of hydration, hepatic necrosis, renal insufficiency, malabsorption, zinc deficiency, iron stores, or cortisone administration (9,10,13). In ESLD, serum protein levels are not reliable parameters for nutritional assessment (9,10,13,15,16,20).

Immune function, often measured by skin antigen testing or TLC, is used often as a nutritional indicator (21). Not only does a depressed nutritional state impair host defense, but in the presence of severe hepatic dysfunction inhibitory factors have been identified which depress immune function (10). Skin antigen testing and delayed hypersensitivity reaction are affected by hepatic failure, electrolyte imbalance, infection, renal insufficiency, immunosuppressive medications, and metabolic stress (13). Immune function indicators are avoided as nutritional parameters in patients with ESLD because they are considered to be immunosuppressed (13).

Because these nutritional parameters are frequently altered by variables other than nutrition (9,10,13-16,20), other indicators have been suggested to determine the nutritional status of these patients. Clinical judgment must take into consideration diet history and physical findings, as well as biochemical measurements (9,13,16).

Subjective nutritional assessment parameters

A “subjective” approach is used at BUMC to assess the nutritional status of liver transplant recipients. The technique was adapted from the original “subjective global assessment” (SGA) by Detsky et al (23) and focuses on information obtained from the patient as well as the dietitian’s observations. The patient is questioned about weight change (loss and/or gain of lean mass, fat mass, or fluid accumulation), nutritional intake, gastrointestinal symptoms, physical capacity, and presence and duration of other conditions that affect nutritional state. The information is ranked into degrees of severity. For example, if the patient is questioned about vomiting, the response is categorized as no vomiting, vomiting for less than one week, or vomiting for at least one week. The observer assesses the degree of the patient’s fat and muscle depletion and degree of ascites or edema. Patients are ranked as well nourished, moderately (or suspected of being) malnourished, or severely malnourished (according to the original SGA). Although this approach is dependent upon both patient recall and the rater’s skill, it has been found to be valid in surgical patients (23,24) and judged to be useful in liver transplant candidates (25). In a study of 20 patients at BUMC, the method was found to have fair to good interrater reliability (25).

Prevalence of Malnutrition in Liver Transplant Candidates

Malnutrition is common in ESLD patients (1,9,13,15,16,22). Nutritional assessment of BUMC liver transplant candidates confirms these reports. Of 435 transplant candidates, 128 (29.4%) were well nourished, 244 (56.1%) moderately (or suspected of being) malnourished, and 63 (14.5%) severely malnourished.

The prevalence of malnutrition in liver transplant recipients underscores the need for appropriate nutritional care before and after liver transplantation (9,10,13,22,26). These nutritional needs can be described as short- and long-term requirements.

Variables Affecting Short-term Posttransplant Nutritional Goals

The short-term posttransplant nutritional goal is anabolism. Specific needs of the recipients are dependent on variables such as present nutritional state, surgical procedures performed at the time of transplant, effects of postoperative medications, and any associated medical complications.

In a study of 74 liver transplant candidates, nutritional status was found to vary with the type of liver disease (16). Ascites was prevalent in patients with chronic active hepatitis, and alcoholic stores were often depleted while protein stores remained within normal limits. Patients with sclerosing cholangitis often displayed only muscle wasting, while victims with primary biliary cirrhosis displayed marked fat and muscle wasting although they retained good synthesis functions of the liver. Patients with any fulminant disease were stressed and acutely depleted. Individual goals are dependent on the nutritional state which is influenced by the nature of the primary liver disease.

Another factor in individual nutritional care plans is the type of transplant surgery. A cholecdochojijunostomy requires more small bowel manipulation than does a cholecdochocholedochostomy and may delay initiation of oral intake. A new transplant procedure called a “cluster” transplant has many nutritional ramifications. This procedure is indicated for malignancies involving not only the liver but also the pancreas, duodenum, or colon. The liver is removed with the patient’s pancreas, duodenum, spleen, proximal jejunum, stomach, and most of the colon. Organ cluster grafts of liver, pancreas, and duodenum are replaced (27). Since many digestive organs are removed, there is a high potential for malabsorption, dumping syndrome, and glucose intolerance.

The third nutrition-influencing factor, medication, is unavoidable because immunosuppressive drugs are essential to prevent organ rejection (CYA), side effects of immunosuppressive drugs such as creatinine (61443), and medications such as corticosteroids, aspirin, citrate, and acetaminophen.

Postoperative nutritional intake varies, depending on the wound complication. These complications can be severe enough to be fatal if a transplant is required on the patient. In this case, the patient is put on a modified diet and brought back to the transplant center for the next surgery.
nutrients. Acute rejection of a transplanted liver often requires additional steroid administration which amplifies the side effects of these drugs. Chronic rejection may result in such severe hepatic damage as to require reinstatement of nutritional principles for ESLD.

Transplant recipients are at high risk not only for rejection but also for infection. The high rate of infection in posttransplant patients may be affected by immunosuppression, the use of antibiotics, preoperative malnutrition, and/or antacids that permit bacterial overgrowth in the stomach (32). In the presence of widespread infection or sepsis, nutritional needs are increased and antibiotic therapy may be initiated. Not only do the infection and fever affect appetite, but the antibiotics may produce diarrhea, taste changes, and anorexia (31).

Renal function also affects nutritional needs. CYA may be nephrotoxic and renal impairment occurs with some frequency following liver transplant (6,32). Alterations in electrolyte therapy, a decrease in protein intake, and restriction of fluid intake to match output may be indicated.

Complications of other organ systems such as pulmonary, biliary, or intestinal tracts can require changes in types and amounts of nutrients, but, more frequently, require a change in the nutritional route. For example, ventilator support with intubation or occurrence of small bowel obstruction requires nutrition by other than oral means.

Hypothermia is another reported postoperative complication of liver transplantation (6,20,32). The response to hypothermia is shivering, vasoconstriction, hyperventilation, and alkalemia, with increased cardiac output and oxygen consumption (6). Increased oxygen consumption and shivering increase the patient’s energy expenditure.

Wound complications also have nutritional effects. The presence of a large open wound or many drain sites requires additional nutrition to compensate for nutrient losses.

Pancreatitis occurs infrequently (4). Mild pancreatitis may only delay the onset of oral intake, but more severe attacks require bowel rest and total parenteral nutrition (TPN).

Table 1

<table>
<thead>
<tr>
<th>Immunosuppressive Drug</th>
<th>Side Effect</th>
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<tbody>
<tr>
<td>Cyclosporine</td>
<td>Nephrotoxicity (8,29,30-32)</td>
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<tr>
<td></td>
<td>Hepatotoxicity (30-32)</td>
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<td></td>
<td>Hypertension (8,29,33)</td>
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<td></td>
<td>Hyperlipidemia (31,34)</td>
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<td></td>
<td>Hyperkalemia (28,31,33)</td>
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<td></td>
<td>Magnesium wasting (8,31)</td>
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<td>Hyperglycemia (20,31,35)</td>
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<td></td>
<td>Gingival hypertrophy (31,36)</td>
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<td></td>
<td>Hirsutism (31)</td>
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<td></td>
<td>Tremor (31,33)</td>
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<td></td>
<td>Paresthesias (31,33)</td>
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<tr>
<td></td>
<td>Headache (33)</td>
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<td></td>
<td>Catatonia and impaired wound healing (30,31)</td>
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<tr>
<td></td>
<td>Hyperglycemia (30,31,33,37)</td>
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<tr>
<td></td>
<td>Hyperlipidemia (31)</td>
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<td></td>
<td>Sodium retention (30,31)</td>
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<tr>
<td></td>
<td>Electrolyte disturbances (30,31,33)</td>
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<tr>
<td></td>
<td>Increased appetite (31)</td>
</tr>
<tr>
<td></td>
<td>Increased calcemia (31,33)</td>
</tr>
<tr>
<td></td>
<td>Development of peptic ulcers (31)</td>
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<tr>
<td></td>
<td>Increased hair growth (31)</td>
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<td></td>
<td>Acne (31)</td>
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<td></td>
<td>Mood swings (31)</td>
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<td>Night sweats (31)</td>
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<td>Bruising of the skin (31)</td>
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<td></td>
<td>Blurred vision (31)</td>
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<td>Moon face (31)</td>
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<td>Joint pain (31)</td>
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<td>Insomnia (31)</td>
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<td></td>
<td>Increased sun sensitivity (31)</td>
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<td></td>
<td>Development of cataracts (31)</td>
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<tr>
<td></td>
<td>Nausea (31)</td>
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<td></td>
<td>Vomiting (31)</td>
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<td></td>
<td>Sore throat (31)</td>
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<td></td>
<td>Altered taste acuity (31)</td>
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<td></td>
<td>Macrocytic anemia (31)</td>
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<tr>
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<td>Nausea (30,31)</td>
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<td></td>
<td>Vomiting (30,31)</td>
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<tr>
<td></td>
<td>Diarrhea (30,31)</td>
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<tr>
<td></td>
<td>Loss of appetite (31)</td>
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<tr>
<td></td>
<td>Fever and chills (30,31)</td>
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</tbody>
</table>

Short-term Posttransplant Nutrient Requirements

Nutrient needs are increased immediately posttransplantation. In one study of eight patients, mean resting energy expenditure (REE) rose 36% to 38% above the predicted resting energy expenditure (PREE) (based on the Harris-Benedict equation) on the first and second days after surgery (38). In another study, measured REE was only 7% higher than PREE (27), but PREE may have been overestimated by calculations employing the patient’s actual weight (including ascites) rather than dry weight. When indirect calorimetry equipment is not available to measure individual postoperative needs, caloric requirements for transplant patients may be estimated at about 1.5 times the basal energy expenditure (BEE) using the Harris-Benedict equation. A range of 140% to 170% of BEE is suggested, or 33 to 40 kcal per kg of ideal body weight (20). At BUMC, the patient’s lowest recent weight is used to estimate dry body weight for calculating energy and protein needs.
The hypermetabolic postoperative transplant patient is in a catabolic state. In a study of eight posttransplant patients, mean nitrogen excretion (urinary urea nitrogen [UUN]) was found to be 20.1 g on the first postoperative day and 24.6 g on the second postoperative day (38). In another study, UUN excretion was less than the previous study (12.9 ± 4.4 g/day), but it was measured on the third postoperative day (27). The large nitrogen losses are due to steroid therapy, muscle catabolism in an unfed state, and stress from surgery (27,30). A protein load of 1.3 to 2 g/kg of dry body weight is recommended (20,30). The BUMC care plan calls for 1.5 g/kg.

Other nutritional changes after transplant must also be monitored (39). Carbohydrate and fat are not restricted in the immediate postoperative period unless serum glucose and triglyceride concentrations indicate intolerance. Sodium and fluid intake may be restricted if a patient retains excess fluid (30). Attention to electrolyte and mineral levels is mandatory. CYA can cause retention of potassium while some diuretics waste potassium (Table 1). Accelerated loss of magnesium has been associated with both CYA (40,41) and diuretic therapy. Depleted serum magnesium levels may lead to tetany or seizures (8,31,40-42). Phosphorus and calcium may also require supplementation (Table 2).

### Table 2

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Short-term Needs</th>
<th>Long-term Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>1.4-1.7 × BEE (20,39)</td>
<td>For weight maintenance</td>
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<tr>
<td></td>
<td></td>
<td>about 1.2 × BEE (39)</td>
</tr>
<tr>
<td>Protein</td>
<td>1.5-2.0 g/kg (20,30,34)</td>
<td>No added sugar, low concentrated carbohydrate (20,30,39)</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>50%-70% of nonprotein calories, decrease if glucose is elevated (30,39)</td>
<td>&lt; 30% of calories as fat, &lt; 10% of calories as saturated fat (39)</td>
</tr>
<tr>
<td>Fat</td>
<td>30%-50% of nonprotein calories, decrease if triglycerides are elevated (39)</td>
<td>&lt; 30% of calories as fat, &lt; 10% of calories as saturated fat (39)</td>
</tr>
<tr>
<td>Fluid</td>
<td>Restrict fluid as needed for edema/ascites (30,39)</td>
<td>4 g (30,31,39)</td>
</tr>
<tr>
<td>Sodium</td>
<td>Restrict to 2-4 g as needed for edema/ascites (30,31,39)</td>
<td>Same as short-term plan</td>
</tr>
<tr>
<td>Potassium</td>
<td>Supplementation/restriction depends on serum potassium level</td>
<td>Encourage intake of high magnesium-containing foods, supplement according to short-term plan</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Supplement when low with 1 Neutra-Phos capsules three times a day</td>
<td>Encourage intake of high phosphorus-containing foods, supplement according to short-term plan</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Supplement when low with 1 Slo-Mag tablet three times a day</td>
<td>Same as short-term plan</td>
</tr>
<tr>
<td>Calcium</td>
<td>Supplement when low or in females near menopausal age or in other patients with history of bone deterioration*</td>
<td>Encourage intake of high calcium-containing foods, supplement according to short-term plan</td>
</tr>
</tbody>
</table>

*Women: Two Florical capsules three times a day, one 0.25 μg calcitriol capsule per day, 0.1 mg estradiol patch changed every 3 days and worn three out of four weeks. Men: exclude estradiol patch.

### Nutrition Support Following Liver Transplantation

The urgent need for increased nutrients immediately posttransplant may require special nutritional techniques. TPN is administered to all liver transplant patients at some centers but is not used routinely at many others (20,30). At BUMC, TPN or tube feeding (TF) is administered only to patients with one or more complications—severe malnutrition, prolonged ileus or ventilator dependence, persistent vomiting or diarrhea, inability to eat adequately, or altered neurologic status affecting eating (39). In 427 transplant patients at BUMC, 140 (32.7%) received some type of nutrition support; 38 (8.9%) received TF alone, 51 (11.9%) received TPN alone, and 51 (11.9%) received a combination of parenteral and enteral nutrition. Nutrition support is used only as an alternative to oral diets. When ileus resolves usually three to four days postoperatively, the patient is advanced to an unrestricted general diet (32,39).

Other nutritional changes after transplant must also be monitored. Carbohydrate and fat are not restricted in the immediate postoperative period unless serum glucose and triglyceride concentrations indicate intolerance. Sodium and fluid intake may be restricted if a patient retains excess fluid. Attention to electrolyte and mineral levels is mandatory. CYA can cause retention of potassium while some diuretics waste potassium (Table 1). Accelerated loss of magnesium has been associated with both CYA and diuretic therapy. Depleted serum magnesium levels may lead to tetany or seizures. Phosphorus and calcium may also require supplementation (Table 2).

**Nutritional Needs in Liver Transplantation**

- **Carbohydrate**: Recommended to be 0.8-1.0 g/kg (20,30,39)
- **Protein**: Recommended to be 1.5-2.0 g/kg (20,30,39)
- **Fat**: Recommended to be 0.6-1.0 g/kg
- **Sodium**: Restricted if a patient retains excess fluid (30)
- **Potassium**: Supervision/restriction depends on serum potassium level
- **Phosphorus**: Supplement when low
- **Calcium**: Supplement when low
- **Magnesium**: Supplement when low

**Other Nutritional Considerations**

- **Electrolytes**: Supplementation/restriction as needed
- **Calcitriol**: Two Florical capsules three times a day, 0.25 μg calcitriol capsule per day
- **Estradiol Patch**: 0.1 mg estradiol patch changed every 3 days and worn three out of four weeks for women.

**Prevention of Complications**

- **Diarrhea**: Antidiarrheal medications may be required.
- **Urinary Tract Infections**: Avoidance of overhydration.
- **Hypokalemia**: Supplement as needed.
- **Hypomagnesemia**: Supplement as needed.
- **Hypertriglyceridemia**: Consider dietary modifications.

**Protein Intake**

- **Postoperative**: 1.5-2.0 g/kg
- **Maintenance**: 1.3-2.0 g/kg

**Caloric Intake**

- **Postoperative**: 1.4-1.7 × BEE
- **Maintenance**: ~30%-50% of nonprotein calories

**Fat**

- **Postoperative**: 0.6-1.0 g/kg
- **Maintenance**: No specific recommendations

**Sodium**

- **Postoperative**: Restrict if a patient retains excess fluid (30)
- **Maintenance**: No specific recommendations

**Potassium**

- **Postoperative**: Supervision/restriction depends on serum potassium level
- **Maintenance**: No specific recommendations

**Phosphorus**

- **Postoperative**: Supplement when low
- **Maintenance**: No specific recommendations

**Calcium**

- **Postoperative**: Supplement when low
- **Maintenance**: No specific recommendations

**Magnesium**

- **Postoperative**: Supplement when low
- **Maintenance**: No specific recommendations

**Electrolytes**

- **Postoperative**: Supervision/restriction as needed
- **Maintenance**: No specific recommendations

**Calcitriol**

- **Postoperative**: Two Florical capsules three times a day, 0.25 μg calcitriol capsule per day
- **Maintenance**: No specific recommendations

**Estradiol Patch**

- **Postoperative**: 0.1 mg estradiol patch changed every 3 days and worn three out of four weeks for women.
- **Maintenance**: No specific recommendations

**Conclusion**

- Proper nutrition support is crucial for posttransplant patients to achieve optimal outcomes.
- Close monitoring of electrolyte and mineral levels is essential.
- Antidiarrheal medications and electrolyte supplementation may be required.
- **Future Directions**: Further research is needed to optimize nutritional support in liver transplant patients.
Low cholesterol diet (37). Steroids and CYA have been implicated in abnormalities in dietary patterns (30). This weight gain is due to an increased appetite, good plant recipients (37,46) seems to respond somewhat to a low fat, 1g (29). The short-term goal is anabolism, long-term goals are maintenance and prevention. Nutrition-related problems which may occur in the long term after liver transplantation include excessive weight gain, hyperlipidemia, hypertension, diabetes, hyperkalemia, edema, and osteoporosis (20,29,30,43-45).

Liver biopsy following liver transplantation reveals cholestasis in some cases. Cholestasis may be secondary to ischemic insult to the donor organ but may be exacerbated by excessive caloric administered by TPN (27). Care not to overfeed patients minimizes the potential for TPN-induced cholestasis (27).

Electrolyte disturbances which may also occur with TPN can be avoided by daily monitoring of laboratory values and adjusting TPN formulations.

Although TF or TPN may be required in the short-term post-transplant phase, the nutritional goal is anabolism, with an oral diet as the route of choice.

**Long-term Posttransplant Nutritional Complications**

Nutritional goals in the long-term post liver transplant phase are different from those during the short-term phase. Whereas the short-term goal is anabolism, long-term goals are maintenance and prevention. Nutrition-related problems which may occur in the long term after liver transplantation include excessive weight gain, hyperlipidemia, hypertension, diabetes, hyperkalemia, edema, and osteoporosis (20,29,30,43-45).

Posttransplant obesity occurs in nearly 40% of BUMC patients one year after liver transplant. In a study of 46 such patients at the Mayo Clinic, median long-term weight gain was 6.5 kg (29). This weight gain is due to an increased appetite, good liver function, steroid therapy, and an attitude of no restraint on eating patterns (30).

The hyperlipidemia which is well documented in renal transplant recipients (37,46) seems to respond somewhat to a low fat, low cholesterol diet (37). Steroids and CYA have been implicated as possible initiators of the hyperlipidemia (34,36). Further research is needed into the occurrence and management of hyperlipidemia in liver transplant recipients.

Hypertension occurs in 50% to 70% of posttransplant patients (29,43,44). Antihypertensive drugs are often needed and mildly restricted sodium diets are encouraged (20,30).

New onset diabetes mellitus can also occur following a liver transplant (29). This may be due to steroid administration, but recent studies implicate CYA as a diabetes-inducing agent (35,45). Since the availability of CYA as a potent immunosuppressive drug, steroid dosages have been reduced with little difference seen in the occurrence of diabetes mellitus (45). Studies with rats suggest that glucose intolerance is a consequence of CYA use, due to the simultaneous development of insulin resistance and inhibition of insulin secretion by beta cells (35).

Three long-term nutritional complications are linked to medications. Hyperkalemia, edema, and osteoporosis result in part from the use of immunosuppressive drugs. Hyperkalemia occurs with CYA (31). Edema can be induced by both steroids and CYA (31) while osteoporosis is a well-known consequence of steroid administration (31).

**Long-term Posttransplant Nutrient Requirements**

Just as the nutritional goals and problems in the short term differ from those in the long term, so do the nutritional needs of the liver transplant recipient also change. Calorie, protein, fat, carbohydrate, sodium, potassium, calcium, caffeine, alcohol, and supplement needs are addressed by the dietitian for each transplant patient (39).

In the long term, caloric requirements diminish to about 120% of the BEE for weight maintenance and protein needs decrease to approximately 0.8 to 1.0 g of protein per kg of body weight. To reduce hyperlipidemia, fat intake is limited to less than 30% of calories with restriction of saturated fat (20,30,39). Simple carbohydrate products should be eaten only occasionally and diabetic diets are instituted when diabetes occurs (20,30,39). Sodium intake should not exceed 3 to 4 g daily to help control blood pressure and fluid retention (20,30,39). If serum potassium remains elevated, dietary restriction is indicated. Calcium must be adequate to compensate for an increased urinary loss secondary to steroids (20,30,39). Intake of caffeine and alcohol is discouraged. Vitamin supplementation is not required in most cases, and dosages of any nutrient above 200% of the Recommended Dietary Allowance is discouraged (Table 2).
specific nutrition problems and required classes for patients and their families on the prevention of nutritional problems.

Conclusion
The nutritional needs of the liver transplant patient are ever changing. Liver transplant patients frequently experience a broad spectrum of nutritional problems. Obesity can occur in the same patient who suffered from malnutrition at the time of transplant a year earlier. Although many questions remain, attention to nutritional needs improves both the short- and long-term outcomes of the liver transplant recipient.

References