Nutrition in the Care of Liver Transplant Patients:

Pre & Post Transplantation
Overview/Objectives

• Nutrition in the Care of Liver Transplant Patients

1. Nutrition Status / Causes of Malnutrition

2. Nutrition Support (TF / TPN)

3. Pre-Transplant Diet (or Early / or Non-candidate Liver patients)

4. Early Post-Transplant Diet vs. Long-term Post-Transplant Diet

5. Poor Intake Tips (Pre- and Post-Transplant)

6. Micronutrient Deficiencies
1. Nutrition Status / Causes of Malnutrition
Prevalence of Malnutrition in Liver Disease

- Current estimates are 15-60%
- 90% of pts with cirrhosis
- 20% of compensated cirrhosis cases
- 50% of decompensated cases
- 57% of cirrhotic inpatients had malnutrition during their admission
- Every patient with alcoholic hepatitis/cirrhosis has malnutrition of varying severity
- 62% alcoholic subjects without liver disease were observed to have malnutrition
- 65-90% of patients with advanced liver disease suffer from malnutrition
- >55% of patients with ESLD + BMI >30-40 have sarcopenia determined on CT
Malnutrition and Liver Disease

- **Inadequate nutrient intake:**
  - Loss of appetite, early satiety, delayed gastric emptying, bloating, abdominal distention, decreased alertness, N/V/D, restrictive diets, altered taste perception - linked to zinc deficiency

- **Metabolic alterations:**
  - Altered glucose, lipid and protein metabolism, energy consumption, decreased glycogen levels, reduced storage of nutrients

- **Malabsorption/maldigestion:**
  - Bile salt deficiency, small bowel bacterial overgrowth, portal hypertensive enteropathy
Two Main Factors Contributing to Malnutrition:

Semi-starvation

- Inadequate intake
- Increased requirements
- Impaired absorption
- Altered transport
- Altered nutrient utilization

± Systemic inflammatory response

- Inflammation
- Hypermetabolic state
- Hypercatabolic state

Jensen et al., JPEN 2009
Patel et al., NCP 2017
Malnutrition is Associated with the Following

- Increased risk of pressure ulcers
- Impaired wound healing
- Immune suppression
- Increased infection rate
- Muscle wasting
- Functional loss
- Increased LOS
- High readmission rates
- Higher treatment costs
- Increased mortality

Tappenden et al., JAND 2013
Consequences of Malnutrition

-Cirrhosis: Malnutrition decreases patient survival, quality of life, recovery from infection and surgery

-ALD: Increased hepatocyte susceptibility to alcohol toxicity
  less muscle mass reduces extrahepatic ammonia detoxification

-OLT: Poor pre-OLT nutrition status = increased LOS, vent support and infections

*Malnutrition can blunt the effectiveness of medical therapies*
Etiology-based Malnutrition Definitions

Nutrition Risk Identified

Inflammation Present? No/Yes

NO
  Starvation Related Malnutrition *Marasmus*

YES
  Mild to Moderate Degree
    Chronic Disease-Related Malnutrition *Cachexia*
  YES
    Marked Inflammatory Response
      Acute Disease or Injury-Related Malnutrition *PEU*

Jensen et al., JPEN 2010
Why Albumin and Prealbumin are Absent

Inflammation

Positive acute-phase reactants:
Increased C-reactive protein, fibrinogen, procalcitonin

Negative acute-phase reactants:
Decreased visceral proteins: albumin, prealbumin, transferrin

- Proxy measure for underlying disease burden and inflammatory condition
- Liver dysfunction and reduced synthesis of proteins
- Prealbumin has a shorter half-life than albumin but same issues
- Identifying the degree of inflammation is necessary
- Alb / prealb can be useful in absence of inflammation with adequate nutrition

White et al., JPEN 2012
Patel et al., NCP 2017
Assessing Energy Intake

Inadequate energy intake and nutrient assimilation results in malnutrition

Recent intake is compared to estimated energy requirements

- Diet order: nutrition support or days NPO prior to admission from OSH
- Diet history: rely on memory, ability to interview, need baseline
- Meal data: depends upon meal order, 76-100% of soup is not adequate
- Calorie counts: lack of documentation, missing meals, takes days to acquire meaningful data, sometimes questionable data

<table>
<thead>
<tr>
<th>Clinical characteristic</th>
<th>Malnutrition in the Context of Acute Illness or Injury</th>
<th>Malnutrition in the Context of Chronic Illness</th>
<th>Malnutrition in the Context of Social or Environmental Circumstances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-severe (moderate) malnutrition</td>
<td>Severe malnutrition</td>
<td>Non-severe (moderate) malnutrition</td>
</tr>
<tr>
<td>(1) Energy intake (reference 30)</td>
<td>&lt; 75% of estimated energy requirement for &gt; 7 days</td>
<td>≤ 50% of estimated energy requirement for ≥ 5 days</td>
<td>&lt; 75% of estimated energy requirement for ≥ 1 month</td>
</tr>
</tbody>
</table>

Hasse and Gautam, 2017
White et al., JPEN 2012
2. Nutrition Support ( TF/EN & TPN )
Benefits of Enteral Nutrition

- **Nutrition benefits of EN:**
  - Calories, protein, micronutrients and antioxidants
  - Substrate for protein synthesis
  - Supporting cellular and mitochondrial function

- **Non-nutrition benefits of EN:**
  - GI: gut integrity, reduce inflammation, motility/contractility, absorptive capacity, maintaining GALT mass/beneficial bacteria, trophic effect on epithelial cells, reduced virulence
  - Metabolic: insulin sensitivity, reduce glycosylation, fuel utilization
  - Immune: maintain MALT, modulate adhesion molecules and key regulatory cells, anti-inflammatory effects

Hasse and Gautam, 2017
Common Enteral (TF) Formulas used

• Peptamen 1.5 with prebio (replaced Peptamen 1.5)
  • Well-tolerated, concentrated formula while on CRRT
• Nepro
  • Concentrated formula with lower level of electrolytes for SPHD
• Peptamen AF
  • Well-tolerated, high-protein, anti-inflammatory formula
• TwoCal HN
  • Most concentrated formula, higher in fat
• Vital High Protein
  • Very high protein, isotonic- great for trickle feeds or trial of TF
<table>
<thead>
<tr>
<th>Order Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peptamen 1.5 with Prebio</td>
<td>Indicated for patients with impaired GI function/diarrhea, poor tolerance to prior enteral formulas (high GI losses) 1.5 calories/ml, 67.6 grams protein/L; 70% MCT (Semi-concentrated; hydrolyzed protein)</td>
</tr>
<tr>
<td>Nepro</td>
<td>Indicated for patients with high K+ / PO4 due to renal function, or medication-related hyperkalemia, hyperphos 1.8 calories/ml, 81 grams protein/L; No MCT (Concentrated; standard/intact protein)</td>
</tr>
<tr>
<td>Two Cal HN</td>
<td>Indicated for patients with fluid overload with low/wnl K+ (and low/wnl PO4), it is high in fat, hypertonic 2 calories/ml, 83.5 grams protein/L; No MCT (Most concentrated; standard/intact protein)</td>
</tr>
<tr>
<td>Peptamen with Prebio</td>
<td>Indicated for patients with severely impaired GI function, contains soluble fiber, isotonic (300 mOsm/kg) 1.0 calories/ml, 40 grams protein/L; 70% MCT (Least concentrated; hydrolyzed protein)</td>
</tr>
<tr>
<td>Peptamen AF</td>
<td>Indicated for inflammatory state patients, used PSC/UC flare to attenuate stress response, high protein + fish oil 1.2 calories/ml, 76 grams protein/L; 50% MCT+n-3 (Less concentrated; hydrolyzed protein)</td>
</tr>
<tr>
<td>Nutrihep</td>
<td>Indicated for pre-/post-liver transplant patients with refractory (to free water) hypernatremia, add protein QID 1.5 calories/ml, 40 grams protein/L; 70% MCT (Semi-concentrated; contains BCAAs)</td>
</tr>
<tr>
<td>Vital HP</td>
<td>Indicated for patients as an early trickle feeding to provide high protein with hydrolyzed protein formula with MCT 1 calorie/ml, 87.5 grams protein/L; 50% MCT+n-3 (Least concentrated; hydrolyzed protein)</td>
</tr>
<tr>
<td>MODULAR: Beneprotein</td>
<td>Protein powder additive which can be used as: 1 scoop BID, TID, or QID, mixed in 60-120ml free water slurry 25 calories/scoop, 6 grams protein/scoop</td>
</tr>
</tbody>
</table>

- Insoluble fiber-containing formulas, such as Jevity, are contraindicated in patients with ESLD since they may counteract effect of lactulose.
- Osmolite is not appropriate in pre-OLT patients 2/2 high sodium content, poor absorption capacity on medications for HE/high GI losses.
- Elevated Tbilii >5 indicates higher degree/risk of fat malabsorption (or confirmed testing), requiring medium chain triglyceride MCT > (long) LCT formulas.
Modular Enteral Products

- Fiber Additive: Nutrisource (soluble) Fiber: 1 or 2 scoops
- Protein Additive: Beneprotein: 1 or 2 scoops
  - Should not be added to tube feeding bag
  - Require flushing before and after to reduce risk of clogging tube
  - Each administration should be documented in Care Connect
    - Flowsheets: Daily Cares tab: add row below NUTRITION and above TUBE FEEDING

**Tube Feeding Administration:**
Mix scoop of powder with (60-120 mL) water until dissolved. Administer by syringe through feeding tube. Flush afterwards with a minimum of 30-60 mL water. Do not put additives in tube feeding bag.

**Oral Administration:**
Stir scoop of powder into at least 4oz of any warm or cold beverage or soft food, including puree. Stir until dissolved. Avoid mixing into acidic liquids like orange juice, sodas or lemonade.
Barriers to Adequate Enteral Nutrition

- Delays in ordering EN
  - Waiting on tube placement or calorie count results
- Initiation at low rate or stuck at trickle feed rate
  - Trickle feed = 360 kcals/day, hypocaloric feed = 1600 kcals/day
- Rate advanced too slowly
- Held too frequently
  - Held for GI bleed and variceal banding.
  - Restart EN in 24-48 hours after GI bleed stops, endoscopic banding
  - Held for elevated gastric residual volumes (GRVs)
- Post-pyloric tubes rec for HE and delayed gastric emptying
- Stopped too soon

Hasse and Gautam, 2017
Improving Enteral Nutrition Delivery

• Tracking EN delivery using I/O records and pump data

• Volume based orders instead of rate based orders
  • Huge change in practice for nursing, so not yet implemented
  • Currently collecting data on actual volume of EN infused

• RDs pending orders in Care Connect
  • Nationally, 42% of RD recs are implemented
  • Diet, oral nutritional supplements (ONS: like Nepro/Ensure),
    tube feeding formula/rate/advancement guidelines, some
    labs/vitamins show up in Saved work for MDs/NPs
Parenteral Nutrition (PN) Guidelines

2016 SCCM/ASPEN Guidelines for the Provision and Assessment of Nutrition Support Therapy in Adult Critically Ill Patient recommends:

1. No PN for first 7 days in ICU for well-nourished patients
2. PN upon admission to ICU for severely malnourished patients
   a. Provide hypocaloric (20 kcal/kg or 80% of energy needs) x 1 week
3. No lipids for first week in ICU
   a. Or limit 100 gm per week if concern for essential fatty acid deficiency (typically occurs in ~3 weeks of inadequate EFAs)

Improved safety of PN: improved glycemic control, avoid overfeeding, use standard PN products and CVC care.
Parenteral Nutrition Best Practices

1. Use insulin to keep BG 140/150-180 mg/dL
2. Dextrose infusion rates < 4 mg/kg/min
3. Provide at least 1.2 gm protein/kg
4. Determine lipid use on individual basis
   a. Avoid EFAD
   b. Utilize SMOF when indicated
5. Patients with cirrhosis often need:
   a. Additional thiamine, folate, zinc and less copper
6. Give IV thiamine (Vitamin B1) prior to starting PN

McCleary et al., NCP 2016
2. Pre-Transplant Diet for Liver Disease (Also for Early / Non-Candidates)
Diet for Pre-OLT or Liver Disease

**Nutrition Goals**

- 35-40 kcal/kg (Adjusted / dry / ideal / actual body weight)
- No protein restriction = one of the causes of malnutrition (high protein)
- High risk of hypoglycemia (less glycogen stored / gluconeogenesis)
- Avoid fasting > 3-6 hrs during day; small, frequent meals through day
- Late evening snack with 50gm complex carbs for LBM retention

Anastacio et al., World J Gastroenerol 2016
Amodio et al., Hepatology 2013
Tsien et al., Hepatology 2015
UCLA Diet Orders

- Low potassium diet
- 2 gram sodium diet: also a low fat diet
- 1000 milligram phosphorous diet: may not be necessary
- Carbohydrate controlled diet: grams of carbs on menu
- Mechanical soft diet: cut up and soft foods
- Thickened liquids: often unpalatable
- Puree diet: premade foods
- Fluid restriction: 1L, 1.5L
  - Coffee, juice, milk, ice cream, soup, gelatin, popsicles, sherbet and oral nutritional supplements (ONS) like Nepro, Ensure count
Well-documented Calorie Counts Help

What is the definition of well-documented?

- All meal receipt slips marked
- All missed meals/snacks denoted and include why
- Any other non-meal foods on Caloric Intake Form
  1. Outside foods brought in (or ordered in)
  2. Snacks between meals, from UCLA or family
  3. Oral Nutrition Supplement (ONS) drinks
  4. Anything else consumed between/as meals
Examples of Appropriate Meal Intake Percentages

- **Refused—0%**: Refused meal completely, or consumed only one or two bites of each item.
- **Poor—25%**: Approximately 25% of entree, or 50% of one item consumed.
- **Fair—50%**: Approximately half of food is consumed. (e.g., 50% of entree, 25% of vegetable and soup left). If total entree is consumed but no other food is touched, record as Poor/25% -- not Fair/50%.
- **Good—75%**: Majority of the meal is consumed, but a significant amount of one or more items is left (e.g., 25% of entree or 75% of vegetable left).
- **All—100%**: Entire meal is consumed except for a minimal amount of food (e.g., less than 25% of vegetable left).

Additional Tips on Enhancing Pre-OLT Nutrition

• Probiotics protective
  • With medications for recurrent minimal hepatic encephalopathy (MHE)
  • Dr. Saab Meta-analysis!

• Prebiotics
  • 25-45 grams daily
  • Nutrisource Fiber
  • Mix with water
  • Soluble fiber foods

• MCT oil supplementation
  • Supplies fat calories without energy usage, to utilize
  • Don’t require bile salts for absorption = good, if cholestatic

• EFAs
  • Essential Fatty Acids (Omega-3)
  • Fish oil may delay disease progression
  • Adequate = reduces infection risk

Anastacio et al., World J Gastroenterol 2016
Bemeur et al., J of Nutr and Metab 2010
Diet Recommendations for Liver Disease

• To prevent or slow the advancement of liver disease, and complications, it is recommended to:
  • Maintain a healthy weight
  • Avoid alcohol
  • Avoid excess iron intake (if iron blood level is in normal range)

• There are a number of healthy foods recommended..
  • The same foods are recommended for cancer prevention / halting
    (Cirrhosis = HCC risk; or a patient may be non-candidate due to cancer)
  • The same foods are considered in long-term healthy eating
    (All can benefit: patients, families, friends, & UCLA STAFF 😊)
<table>
<thead>
<tr>
<th><strong>CHOOSE</strong></th>
<th><strong>LIMIT/AVOID</strong></th>
</tr>
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<tbody>
<tr>
<td>Plant-based fats such as olive oil, avocado*, nuts* and seeds*, cold flaxseed oil, pure MCT oil or coconut oil in moderate amounts</td>
<td>Inflammatory polyunsaturated vegetable oils (mostly all others except olive/avocado oils) &amp; Trans-fats (partially hydrogenated oils found in many processed baked and fried foods)</td>
</tr>
<tr>
<td>Omega 3 fatty acids found in wild salmon, herring/sardines (3.5 oz. per week)</td>
<td>Saturated fats (butter, lard, ghee, cheese, cream) Note: some is okay/possibly beneficial if there is a history of alcoholism</td>
</tr>
<tr>
<td>Foods rich in soluble fiber (oats, barley, cooked dried beans*, and peas) and resistant starch (such as tigernuts - a newer food on the market that feeds your healthy gut bacteria)</td>
<td>Low fiber processed foods and refined grains (white breads, pasta, rice, and snack foods)</td>
</tr>
<tr>
<td>Vegetarian proteins (beans/lentils*, nuts/seeds*, nut butters*)</td>
<td>Red meats (beef, pork, lamb, bison/buffalo) Avoid shellfish &amp; raw fish (vibrio risk)</td>
</tr>
<tr>
<td>Eat a variety of fruits, especially dark berries, and more vegetables (2½ cups veggies daily!) Especially broccoli/cruciferous</td>
<td>Processed meats (hot dogs, cured meats, deli/lunchmeat, and breakfast meats)</td>
</tr>
<tr>
<td>Eat more plain yogurt* for healthy gut bacteria (can be non-dairy too) add flavor yourself (such as warmed frozen berries)</td>
<td>Refined sugar (all sugars, high fructose corn syrup, agave and maple syrups, jelly/jam, sodas, candy) artificial sweeteners still affect glucose tolerance (so limit/avoid if able)</td>
</tr>
<tr>
<td>Mix in a lot of anti-inflammatory spices, herbs, and roots (turmeric, ginger, Ceylon cinnamon)</td>
<td>Reduce intake of high heat oil-based sautéed, fried, or roasted, browned, and charred foods</td>
</tr>
<tr>
<td>Regular coffee is okay (if okayed by your MD)</td>
<td>Avoid Alcohol-containing beverages &amp; foods</td>
</tr>
</tbody>
</table>
4. Early Post-Transplant Diet vs. Long-term Post-Transplant Diet
Early Post-Operative Nutrition Goals

• **Ideal:** Clears / Diet for PONV vs. TF (if malnourished) ~12-24 hrs, if stable

• **Common:** Stable / extubated / await bowel function / safe to swallow ?

• **Enhanced Recovery After Surgery (ERAS) Protocols:**
  - Used in Liver Surgery (not OLT Guideline at this time; only a case report at this time, but we may see this coming down the pipeline - monitor the lit)
  - Significant reductions in total hospital stays, IV fluids, post-op complications, and duration of epidural usage in ERAS groups
  - Simple/cheap interventions often result in significant direct medical and indirect non-medical cost savings in ERAS groups vs. traditional care
  - **Example:** Chewing gum has been shown to reduce risk of post-op ileus by stimulating various gastric hormones, saliva, pancreatic juices, and may reduce the time to pass flatus / time-to-first BM

Mellooul et al., World J Surg 2016
Anastacio et al., World J Gastroenerol 2016
Mullin et al., GI and Liver Diseases, 2012
Early Post-Transplant (PO) Diet / Adding TF/EN

- UCLA diet order options after advancement from Clears
  - **Low Potassium**: (K+ control, PRN – liberal until K+ trends >4.9)
    - No Added Salt on this menu – if patient desires and okay: request RD!
  - **Carbohydrate Controlled**: (CHO control, PRN – liberal till BG >150)
    - No Added Salt on this menu – if patient desires and okay: request RD!
  - **2 Gram Sodium**: (Na control, PRN – liberal till swelling/Na <120)
    - Typically not unless post-transplant ascites, excessive fluid retention
  - **Mechanical Soft / Pureed**: (Texture-dysphagia, PRN – as per SLP)
    - If patient has not had a recent swallow eval for upgrades – ask!
  - **Gluten Free or Vegan or Pediatric**: (As indicated PRN)

*If patient not meeting >60% estimated goal in 1st week - add TF!*
Does the patient/family have a copy of the TRANSPLANT FOOD SAFETY MENU INSERT?

**HIGH-RISK FOODS FOR TRANSPLANT PATIENTS**

Unpasteurized (raw) fruit juices, unpasteurized (raw) ciders, raw juices are not recommended.

Cold deli meat, or processed-luncheon meat (unless served "steaming hot")

**MENU ITEMS ALLOWED DURING HOSPITAL STAY**

- **Beverages:** Fruit Juices
- **Build Your Own Sandwich:**
  - Turkey
  - Roast Beef
  - Hot (Deli meat) Ham*

**UCLA EXPLANATION**

- All fruit juices served on our menu are pasteurized.
- The turkey and roast beef on our menu are cooked fresh and sliced on site. Cold deli ham (processed-luncheon meat) sandwiches are **not allowed**. Please request a hot sandwich if ordering ham.*
- Raw or undercooked eggs, such as over easy, over medium or soft-poached/boiled eggs with runny egg yolks (unless using "in-shell pasteurized" eggs) are **not allowed**.

**Sandwich Sides:**
- Coleslaw
- Macaroni Salad
- Tuna Salad
- Chicken Salad

**Build Your Own Sandwich:**
- Swiss Cheese*
- Provolone Cheese*
- American Cheese*

**Signature Sandwiches:**
- Grilled Vegetable Sandwich
- Entree Salads:
  - Greek Salad
  - Tuscan Salad
  - Little Italian Kitchen:
    - Sicilian Pasta
    - Cheese Plates*

**Cold deli salads such as tuna, chicken, and/or egg salad stored for greater than 72 hours.**

**A La Carte Breakfast:**
- Over Easy Eggs
- Over Medium Eggs

**Obayashi, NCP 2012**
[https://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/UCM312793.pdf](https://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/UCM312793.pdf)
Accessed 7/11/2018
Food Safety Review - Post-OLT (also Pre)

The following tips will lower the risk of foodborne illness.

1. Wash hands well and frequently with soap and water
   Before handling foods and especially after handling pets, garbage, gardening, using the restroom and between handling raw and cooked foods.

2. Do not eat raw or undercooked meat, fish, poultry or eggs
   This includes: sushi, ceviche, steak tartare, raw cookie dough, Caesar salad dressing prepared with raw eggs, raw milk and cheeses made with raw milk. Undercooked shellfish is especially dangerous for liver patients. Runny egg yolks (over-easy) okay if using pasteurized eggs (+UCLA).

3. Defrost frozen foods in the refrigerator or in the microwave
   Not on the counter or in the sink. Do not refreeze defrosted, uncooked foods (okay to freeze after cooking). Families should practice at home.

Obayashi, NCP 2012
The following tips will lower the risk of foodborne illness.

4. Wash fresh fruits and vegetables well before eating

Any brought in by family/friends should be washed well. Patients may use a scrub brush if desired. Throw away outer leaves of leafy vegetables such as lettuce and cabbage.

5. Cook and store foods at proper temperatures

Keep foods at safe temperatures: hot foods above 140° F and cold foods below 40° F. Keep perishable foods out the fridge for no longer than 1-2 hours. Any foods served that should be kept in the fridge should be eaten within 1-2 hours.

6. Check expiration dates and do not consume expired foods

Leftovers should be eaten within 1-2 days.

Obayashi, NCP 2012
The following tips will lower the risk of foodborne illness.

7. Do not use canned goods that are swollen/dented/damaged
   Wash lids before opening cans / sparkling waters (or sodas if okay).
8. Use separate cutting boards for raw and cooked foods
   Sanitize work surfaces, knives, utensils, and cutting boards before using them to serve cooked foods. Families should practice at home.
9. When shopping, pick up perishable items last
   Refrigerate all perishable foods within 2 hours.
## High-Risk Foods to Avoid While Taking Immunosuppressant Medications

<table>
<thead>
<tr>
<th>FOODS TO AVOID</th>
<th>EXAMPLES TO AVOID</th>
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</thead>
<tbody>
<tr>
<td>Raw or undercooked meats or poultry</td>
<td>Rare or medium-rare beef or pork, Cueritos, Pickled meats, Tartares</td>
</tr>
<tr>
<td></td>
<td>Unpasteurized pâtés or meat spreads (Canned, pasteurized meat spreads and pâtés are safe to eat.)</td>
</tr>
<tr>
<td>Raw or undercooked seafood</td>
<td>Sushi, Ceviche, Raw oysters, Smoked fish, lox, Cold pre-cooked seafood (OK if reheated to a safe temperature)</td>
</tr>
<tr>
<td></td>
<td>Raw shelled seafood, unless cooked until shells open and opaque white – if allowed by your hepatologist, Fish roe and caviar</td>
</tr>
<tr>
<td>Raw or undercooked eggs</td>
<td>Runny yolks, over easy, soft/medium boiled or lightly poached, <em>unless using pasteurized eggs</em> (Well-done eggs are safe to eat.)</td>
</tr>
<tr>
<td></td>
<td>If these contain raw egg: -Caesar dressing, -Homemade smoothies, -Tiramisu, -Homemade eggnog, -Uncooked cake batter, -Uncooked cookie dough</td>
</tr>
<tr>
<td>Unpasteurized (raw) milk and cheeses and pasteurized soft cheeses if not well-refrigerated</td>
<td>Mold-ripened cheeses such as Brie and Camembert, Feta cheese and goat cheese (OK if well-refrigerated at home, or cooked)</td>
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<tr>
<td></td>
<td>Blue-veined cheeses such as Stilton and Gorgonzola, Queso fresco and queso blanco (OK if pasteurized or hot)</td>
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</table>
The above is included in the Post-Transplant Nutrition Packet – provided in the class taught by the Dietitian (Wednesdays 1:30pm). Families can sign up with in-house Coordinator to attend.

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<td>Unpasteurized: kimchi, sauerkraut, raw pickled vegetables, or raw honey</td>
</tr>
<tr>
<td>smoothies, or homemade fermented</td>
<td>Raw and alcohol-containing kombucha</td>
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<tr>
<td>foods</td>
<td>Homemade yogurt or kefir</td>
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<td></td>
<td>Fresh/raw drinks from juice or smoothie bars</td>
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<td></td>
<td>Raw apple cider vinegar</td>
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<tr>
<td>Processed meats served cold or room</td>
<td>Cold or room temperature, processed lunchmeat, deli meat, hot dogs,</td>
</tr>
<tr>
<td>temperature</td>
<td>jerky, salami, and sandwiches or subs made with these meats</td>
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<tr>
<td></td>
<td>(Heating these foods to steamy-hot safe temperatures may make them safer to eat.)</td>
</tr>
<tr>
<td>Raw sprouts and restaurant salads</td>
<td>Raw alfalfa or other vegetable sprouts</td>
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<td></td>
<td>Raw bean sprouts</td>
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<td>Restaurant salads</td>
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<td>Salad bars and buffets</td>
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<td></td>
<td>(Cooked/sautéed sprouts are safe to eat.)</td>
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<td></td>
<td>(Salads prepared safely at home are OK.)</td>
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</tbody>
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Post-Transplant Nutrition / Diet Goals

**UCLA Health**

**NUTRITION GOALS AFTER TRANSPLANT**

Congratulations on your transplant! Now that you are recovering from transplant, nutrition will play an important role. Read below to see what is recommended in your diet.

☑ Beware of the “never-nevers”: Avoid grapefruit, pomegranate, starfruit, pomelo, Seville or bitter orange, orange marmalade and beverages containing these fruits, because they may interact with your transplant medication. Never drink or cook with alcohol, and avoid ordering foods made with alcohol. Discuss any herbal teas with your dietitian before use.

☑ Practice food safety: Your immune system is suppressed by your transplant medications. This will prevent rejection of your new organ, but also make you more susceptible to infections, including foodborne illness and food poisoning. Food safety is FOREVER.

☑ Limit potassium: Your transplant medications may cause the level of potassium to rise in your blood. While your medications are being adjusted, you may need to follow a low potassium diet for anywhere from two weeks to three months or more when home after transplant. The dietitian in clinic will confirm when it is safe to eat high potassium foods again.

☑ Follow a high-calorie, high-protein diet: Focus on this the first three months after transplant. This will help with wound healing and to gain back muscle and weight that you may have lost prior to your transplant, and/or after transplant.

☑ Control blood glucose: The steroids you are taking may cause high blood sugar. You can control your blood sugar by eating moderate portions of high-fiber carbohydrate foods like (low-potassium) whole food starches, fruits, vegetables. Eat less sugar/dessert/candy/soda/juices.

☑ Follow a heart-healthy diet: Start this after three months of being home from the hospital. Choose lean proteins such as chicken, fish, or vegetarian proteins, healthy fats such as olive oil, and a variety of fruits and vegetables. To promote long-term health, avoid fatty animal products like bacon, ribs, cheese, and very salty foods.

☑ Prevent osteoporosis: Steroids may contribute to osteoporosis. Eat calcium-rich foods daily such as kale, milk, or fortified rice milk and cereals. Do weight-bearing activities to help your bones. Take the supplements prescribed by your doctor (Vitamin D, Magnesium, +/- Calcium).

☑ Take your vitamin and minerals: After transplant, your body may need extra nutrients to avoid deficiencies. Taking a multivitamin with minerals daily (or renal vitamin) is advised. You may be asked to take extra supplements to treat low levels, or if you have symptoms such as loss of taste, hair loss, or confusion. Speak with your dietitian if you have questions.

☑ Coumadin/Warfarin: IF you are on this medication to thin your blood, it is important to have a consistent intake of Vitamin K from day to day. Vitamin K is found in many dark green vegetables such as spinach and broccoli.
Post-Transplant [Temporary*] Low Potassium Diet

- Immunosuppressant transplant medication = high K+
- Medication adjustments ~1 month in Thursday clinic
- REC: Low potassium diet **starts at discharge** from UCLA
  - We can treat elevated K+ - if too high in-house, to encourage PO
  - Need RNs to WATCH for this [supps?] as ideal K+ goal = 3.5 - 5.0
  - If K+ trending >4.8/4.9 ongoing, may add Low K+ diet at hospital

- **How long** does the pt follow a Low K+ diet?
  - Two weeks to three months (or more) when home after transplant.

*The dietitian (Jennifer Krohn) in clinic, will confirm when it is **safe** to start adding high potassium foods back into the diet.*
Low and High Potassium Fruits / Other Foods

<table>
<thead>
<tr>
<th>LOW POTASSIUM (Portion size: 1/2 cup unless otherwise stated = Less than 200 mg)</th>
<th>HIGH POTASSIUM (Portion size: 1/2 cup unless otherwise stated = More than 200 mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FRUITS</strong></td>
<td></td>
</tr>
<tr>
<td>Apple/Applesauce</td>
<td>Pear–Asian</td>
</tr>
<tr>
<td>Apricot, raw (1)</td>
<td>Pineapple, canned</td>
</tr>
<tr>
<td>Blackberries/boysenberries</td>
<td>Pineapple juice</td>
</tr>
<tr>
<td>Blueberries (1 cup)</td>
<td>Strawberries</td>
</tr>
<tr>
<td>Cherries, fresh (12)</td>
<td>Tangerine (1)</td>
</tr>
<tr>
<td>Cranberries</td>
<td>Mango (1 cup)</td>
</tr>
<tr>
<td>Grapes (15)</td>
<td>Guava</td>
</tr>
<tr>
<td>Grape juice</td>
<td>Honeydew</td>
</tr>
<tr>
<td>Lemons/limes (2)</td>
<td>Kiwi (1)</td>
</tr>
<tr>
<td>Peach, fresh</td>
<td>Mango</td>
</tr>
<tr>
<td>WATERMELON</td>
<td>Orange/tangelo</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>OTHER FOODS</strong></td>
<td></td>
</tr>
<tr>
<td>Black tea (16 oz)</td>
<td>Popcorn, air-popped</td>
</tr>
<tr>
<td>Breads/tortilla–white/com</td>
<td>Quinoa** (1 cup)</td>
</tr>
<tr>
<td>Cake–angel food/yellow</td>
<td>Rice/barley** (1 cup)</td>
</tr>
<tr>
<td>Coffee (8 oz)</td>
<td>Rice milk–unsweetened</td>
</tr>
<tr>
<td>Couscous/bulgur** (1 cup)</td>
<td>Ricotta/cottage cheese</td>
</tr>
<tr>
<td>Ice cream*</td>
<td>Tabouli–no tomato</td>
</tr>
<tr>
<td>Oatmeal ** (1 cup)</td>
<td>Neptune supplement</td>
</tr>
<tr>
<td>Pasta/noodles–white</td>
<td>Boost–Calorie Smart</td>
</tr>
<tr>
<td>Pie–no nuts, chocolate</td>
<td>Boost–Glucose Control</td>
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</tr>
</tbody>
</table>
Low and High Potassium Vegetables / Legumes

<table>
<thead>
<tr>
<th>Low Potassium</th>
<th>High Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus (6 spears)</td>
<td>Lentils</td>
</tr>
<tr>
<td>Bell pepper</td>
<td>Artichoke (1/2)</td>
</tr>
<tr>
<td>Cabbage, cooked</td>
<td>Avocado (1/4)</td>
</tr>
<tr>
<td>Cabbage, raw (1 cup)</td>
<td>Bamboo shoots</td>
</tr>
<tr>
<td>Carrots, cooked</td>
<td>Beans—all/edamame</td>
</tr>
<tr>
<td>Cauliflower, cooked</td>
<td>Beets</td>
</tr>
<tr>
<td>Celery (1 stalk)</td>
<td>Beet/tunip greens</td>
</tr>
<tr>
<td>Coleslaw</td>
<td>Bok choy</td>
</tr>
<tr>
<td>Collard/mustard greens</td>
<td>Broccoli</td>
</tr>
<tr>
<td>Corn</td>
<td>Brussels sprouts</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Cactus/nopales</td>
</tr>
<tr>
<td>Eggplant (1 cup)</td>
<td>Carrots, raw</td>
</tr>
<tr>
<td>Endive (1 cup)</td>
<td>Carrot juice</td>
</tr>
<tr>
<td>Green beans</td>
<td>Chili pepper</td>
</tr>
<tr>
<td>Green peas</td>
<td>Chinese cabbage</td>
</tr>
<tr>
<td>Water chestnuts</td>
<td>Chickpeas/hummus</td>
</tr>
<tr>
<td>Wax beans</td>
<td></td>
</tr>
</tbody>
</table>

Re: Protein sources and Dairy / Non-dairy choices

*Eggs, fish, poultry, and meat are allowed – discuss with your dietitian if you are vegetarian/vegan.*

*1/2 cup of dairy or almond milk is OK daily IF your potassium level is normal. **Refers to cooked grains.*

Until the clinic transplant dietitian allows otherwise.
Long-term Post-Transplant Diet (> 3 months)

• **After Three Months of Being HOME (after discharge)**

  • **Heart Healthy:** (Na + Fat control, All patients after home x3 mos)
    - Due to risk of CVD / HTN / +/- with DM
    - Hopefully the patient’s potassium has normalized (renally / meds)

  • +/- **Carb Controlled:** (Monitoring CHO portions)
    - If elevated BG
    - Common if prior +DM
    - Steroids obviously exacerbate, but may improve with time

→ Along with: **Food Safety & Avoiding the Never-Nevers FOR LIFE**
Long-term Post Transplant Considerations

OTHER FACTORS

• Weight Management
  • Excess caloric intake control, no shakes?
  • +/- Steroid-related gains – Carbohydrate Controlled = portion control

• Fatty Liver Recurrence Risk
  • Portion / sugar control - PRN
  • No HFCS (High Fructose Corn Syrup), +/- Carbohydrate Controlled

• Bone Health
  • Steroids use and muscle wasting increase risk for osteoporosis
  • Highest bone loss in first 3-6 months post-OLT; need to weight bear
  • Take (if) prescribed Vitamin D, Magnesium, +/- Calcium (Protocol)
5. Poor Intake Tips - for UCLA & HOME (Pre- and Post-Transplant)
High Calorie/Protein Snacks

Real Food is ALWAYS best.

- Hard boiled eggs or egg salad with mayo
- Tuna or chicken salad with extra mayo
- ½ sandwich made with fresh chicken/turkey
- Fruit with ½ cup low sodium cottage cheese, or ricotta cheese
- 2 slices mozzarella cheese with unsalted crackers
- Cooked quinoa (or coffee/tea) with protein powder + vanilla MCT oil blended in [+/-cinnamon]
High Calorie/Protein Tips

- Dip bread in olive oil +/- balsamic vinegar and/or hummus (garbanzo bean + sesame dip)
- Pour extra portions of olive oil on rice, quinoa, pasta, or after water-sauteing vegetables
- Add raw virgin coconut oil to toast or roasted vegetables (with or without cinnamon)
- Add butter in moderation
- Mix in MCT oil (non-emulsified) flavored versions
- Eat more fatty fish such as low sodium sardines or salmon
- Mix in plant-based pea or whey protein powder
If Patients are Unable to Eat Enough Food

**Oral Supplements at UCLA**

<table>
<thead>
<tr>
<th>Ordering Oral Nutrition Supplements* [ONS]</th>
<th>In PRE &amp; POST - Liver Transplant</th>
<th>Calories / Protein (Per container)</th>
<th>Flavors Available In-house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nepro</td>
<td>Appropriate if K+/PO4 elevated, Na low, limited gastric capacity/liquid overload</td>
<td>425 kcal, 19 grams protein</td>
<td>Vanilla / Butterpecan (Concentrated)</td>
</tr>
<tr>
<td>Two Cal HN</td>
<td>Appropriate if K+/PO4/BG wnl, Na low or wnl, limited gastric capacity/liquid overload</td>
<td>475 kcal, 20 grams protein</td>
<td>Vanilla** (Concentrated)</td>
</tr>
<tr>
<td>Ensure High Protein</td>
<td>Appropriate if K+/PO4/Na wnl, +/-BG elevated</td>
<td>160 kcal, 16 grams protein</td>
<td>Vanilla / Chocolate** -Chocolate appropriate if K+ &lt;4.9</td>
</tr>
<tr>
<td>Ensure Enlive</td>
<td>Appropriate (up to BID) if K+/PO4/Na/BG wnl, no fluid overload; <em>High K+</em></td>
<td>350 kcal, 20 grams protein</td>
<td>Vanilla / Chocolate / Strawberry -Avoid after discharge post-OLT**</td>
</tr>
<tr>
<td>Glucerna</td>
<td>Appropriate if K+/PO4/Na wnl, +/-BG elevated; <em>High K+</em></td>
<td>180 kcal, 10 grams protein</td>
<td>Van / Choc / Strawb / Butterpecan -Avoid after discharge post-OLT**</td>
</tr>
<tr>
<td>Peptamen with Prebio</td>
<td>Appropriate if short gut, excessive malabsorption, poor ONS tolerance</td>
<td>250 kcal, 10 grams protein</td>
<td>Vanilla**</td>
</tr>
<tr>
<td>Ensure Clear</td>
<td>Appropriate if cannot tolerate creamy ONS, BG wnl, (low in K+ and PO4)</td>
<td>200 kcal, 7 grams protein</td>
<td>Apple / Mixed Berry (Juice-based)</td>
</tr>
</tbody>
</table>


**Supplements high in potassium should be avoided at home in the early post-transplant period, 2/2 hyperkalemia/MI risk.
If Unable to Eat Enough Food at Discharge

- **Oral Supplements at Home** (Some Ideas)

<table>
<thead>
<tr>
<th>Product</th>
<th>Flavor Options</th>
<th>Purchase</th>
<th>Carbohydrates</th>
<th>Potassium</th>
<th>Protein</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boost Glucose Control</td>
<td>• Vanilla or strawberry (Do not use chocolate)</td>
<td>• Many drugstores carry</td>
<td>16 gm</td>
<td>50 mg</td>
<td>16 gm</td>
<td>190 kcal</td>
</tr>
<tr>
<td>Boost Calorie Smart</td>
<td>• Vanilla (Do not use chocolate)</td>
<td>• Many drugstores carry</td>
<td>16 gm</td>
<td>50 mg</td>
<td>16 gm</td>
<td>190 kcal</td>
</tr>
<tr>
<td>Nepro</td>
<td>• Vanilla, butter pecan, or mixed berry</td>
<td>• Order online</td>
<td>38 gm</td>
<td>250 mg</td>
<td>19 gm</td>
<td>425 kcal</td>
</tr>
<tr>
<td>Mix Your Own</td>
<td>• ¾ cup rice milk (unsweetened)</td>
<td>• See if drugstore carries</td>
<td>~25 gm</td>
<td>~200 mg</td>
<td>~15 gm</td>
<td>~230 kcal</td>
</tr>
</tbody>
</table>

Drink a low-potassium, low-carbohydrate supplement with/between meals - ask your dietitian.
If Snacks **AND** Supplements are Insufficient

• **Additional Ideas**

  • **Other brands/types of Oral Supplements** cleared by liver transplant dietitian for the patient / or make their own
    • Review labs history re: BG, K+, PO4
  • **Adding Whey protein** provides BCAAs (Branched Chain Amino Acids) beneficial for adding Lean Body Mass (LBM)
    • “Plain” is better with no extra additives liver has to process
  • **Adding MCT (Medium Chain Triglycerides) Oil**
    • Up to 1-2 Tbsp - up to TID; especially in fat malabsorption

  <Pre’s Study: providing ~500kcal, 20gm prot 9pm-7am helps to block/spare "starvation muscle-breakdown overnight”>
Homemade High Calorie/Protein Drinks or Shakes – Recipe Ideas:

- 8 oz Almond, Soy, Coconut, Oat, Rice, Hemp, Quinoa, or Cashew Milk, or a type of Dairy (Goat/Cow) Milk (or Sheep milk yogurt + ice)
- Mixed with plain Whey or Pea protein powder (or other plain, Plant-based protein powder)
- For Flavoring + Nutrients, consider adding:
  - Fresh or frozen fruits – especially dark berries
  - Ground spices: Ceylon cinnamon, ginger, nutmeg
  - Fresh herbs (mint), or roots (ginger/turmeric)
  - Vanilla/mocha/plain MCT oil (non-emulsified)
  - Avocado and/or nuts/seeds
If PO intake is **Still Less than Estimated Needs**

- **Appetite Stimulants**
  - **Megace**: if no clotting issues, nor contraindicated
    - High risk PE/DVT
  - **Remeron**: aid appetite via “happy pill”, if not contraindicated
    - Can increase sleepiness
  - **Marinol**: used when others not preferred
    - May aggravate foggy mind in pre’s and/or post’s
  - **Cyproheptadine**: also aids nausea
    - Can increase sleepiness (one patient c/o feeling altered)
When to Add / Keep Nutrition Support (TF / TPN)

• **Supplemental TF when indicated**
  - Calorie Count < 60% estimated needs intake?
  - Night-time Enteral Nutrition (EN) Tube feeding (TF)
  - Or 100% TF low volume/concentrated formula with poor PO

• **Why TPN not ideal in Pre-Transplant Liver Patients:**
  - Fluid / lytes balance = more ascites, less PO → "Txr to MICU Na 119" …
  - Liver / biliary stress = **Cholestatic:** watch bili, chk ggt; **Not:** watch alk phos
  - But, if the gut **cannot be fed** (i.e. GIB) or **no TF-EN access / ability**
    - Then adding low volume [concentrated!] supplemental TPN, good!
6. Micronutrient Deficiencies
Main Micronutrients to Focus on 1st in Liver Patients

<table>
<thead>
<tr>
<th>Vitamins and Minerals</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 (thiamine)</td>
<td>Commonly low with any cirrhosis; or history of alcoholism. Deficiency can lead to confusion</td>
</tr>
<tr>
<td>Zinc</td>
<td>Commonly low especially if experiencing diarrhea. Deficiency can lead to altered / loss of taste</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Commonly low in all forms of liver disease. Deficiency can lead to weak / brittle bones, infections</td>
</tr>
<tr>
<td>Iron</td>
<td>Iron supplement discouraged unless your blood iron level is low, and prescribed by a doctor temporarily to fix it *If you have hemochromatosis, avoid foods rich in iron such as red meat, vitamin C supplements and cooking with iron-containing pots or pans</td>
</tr>
<tr>
<td>Copper</td>
<td>*If you have Wilson's disease, avoid copper supplements, copper cookware and choose low copper foods</td>
</tr>
</tbody>
</table>

Mullin et al., GI and Liver Disease, 2012  
Bemeur et al., J of Nutr and Metab 2010
B1

AKA: THIAMIN(E), or Vitamin B1

1. Why look at this?
   Help your pt (with your team) to resolve their:
   AMS/HE, Edema, N/V/Abd Pain, Lactic acidosis, & more

2. How to know if your pt is deficient?
   New Standard: 2 of 4 of the Caine Criteria
   1) AMS/Mild Memory Impairment (confusion/coma)
   2) Deficiency of Intake (~10 days/shorter +additional losses)
   3) Occulomotor Abnormalities (nystagmus/opthalmoplegia)
   4) Cerebellar Dysfunction (gait ataxia, other)
   Confirmation: Deficient (virgin) TPP/TDP level < 70 nmol/L
   Note: "Classic Triad" isn't so classic (only 10-35%); outdated

3. Ramifications for pts, if we "miss" it?
   Irreversible brain damage, increased mortality/death

4. How should we treat it?
   Immediately (draw baseline, & treat IV)
   Before nutrition support -> B1 def
   Low Risk, High ROI

Vasan et al., Stat Pearls Accessed 1/20/2018
Day et al., CMAJ 2014
Galvan et al., Eur J Neurol 2010

UCLA Health
Thiamine (Vitamin B1)

- **Risks if not repleted adequately or timely**
  - Irreversible brain damage
  - Refractory fluid retention
  - Unknown etiology of GI distress: N/V/Abdominal pain
  
  *Wernicke’s & Korsakoff’s syndrome often undiagnosed, as “chalked up to H.E.”*

- **Liver patient specific issues**
  - ALWAYS check/recheck LEVEL if any encephalopathy, AMS/confusion
  - Any cirrhotic patient: +Low PO/Dialysis/Diuretics
  - Liver patients can be sub-clinically deficient (truly low even if wnl)
  - Article quote: “Better to give too much B1 than too little too late…”

Butterworth, Metab Brain Dis 2009
Galvan et al., Eur J Neurol 2010
Thiamine (Vitamin B1), Dosing Strategies

• **Pre-Transplant Standard**
  - Dose prophylactically *IV* in all cirrhotic patients & any patient on HD/CVVHD/diuretics @ 100 mg IV daily for losses
    - Difficult to cross blood brain barrier: may need ~1,500 mg in 24 hrs
    - If deficient & symptomatic, or refractory HE, prudent to give higher doses per to RCP London recs (Literature says: U.S. “behind”)

• **Post-Transplant Standard**
  - Dose patients with 100 mg PO as insurance against poor intake, HD/CVVHD/diuretics, which all waste B1 (vs. TID maintenance)
    - Vitamin B1 metabolic enzymes may be damaged in cirrhotic patients so it cannot cross BBB at lower levels; PO 100 mg TID = ~4 mg absorption

*Potentially in the future, IV Thiamine (100 mg TID) may be utilized in ALL critical care patients admitted to ICU settings (as is done in Europe)*

---

Vasan et al., Stat Pearls Accessed 1/20/2018
Day et al., CMAJ 2014
Galvan et al., Eur J Neurol 2010
Xie et al., World J Gastroent 2017
Zn

AKA: ZINC

1. Why look at this?
Help your pt (with your team) to resolve their: BG lability, Hyperammonemia, Dys-guesia/osmia, Catabolism, ?Diarrhea

2. How to know if your pt is deficient?
~Confirmation: Deficient Zinc (plasma) level < 60 mcg/dL when CRP is < 20 mg/L ...

3. Ramifications for pts, if we "miss" it?
Astocyte swelling, Anorexia, -N balance despite adequate intake Increased copper absorption [--> fatty liver?], Hair loss, Infxns, Impaired wound healing [--> surgical wound dehiscence?]

4. How should we treat it?
Immediately (draw baseline, & treat PO or IV if on PN) Do not wait for the level, Rx, then adjust per labs Low risk (short term), High ROI
Zinc (Zn)

- **Risks if not repleted adequately or timely**
  - Inability to adequately metabolize ammonia (H.E. / brain damage)
  - Further susceptibility to infections

- **Liver Pt specific issues**
  - ALWAYS check LEVEL in all "symptomatic H.E." patients
  - Even in clear-minded patients despite high ammonia levels
  - If borderline levels (but wnl) and patient has high GI losses - prudent to dose them at 220mg daily x14days -- as level may drop further soon !
  - High risk for deficiency with high stool output on HE meds or Magnesium (ie. If on Lactulose [Pre] / Magnesium [Post], need to check zinc!)

Himoto et al., Nutrients 2018
Mohammed et al., NCP 2012
Zinc (Zn), Dosing Strategies

• Pre- & Post- Transplant Standard

  • 220 mg ZnSO₄ daily x 14 days, & recheck level 1 week after supplementation (some recommendations are up to BID or TID)
    • Some literature promotes 50 mg elemental daily in all pre-livers
    • If Zinc is supplemented and returns low again …
      • Need to also Check RBC Copper, Ceruloplasmin – if re-supplementing
      • Or if Fatty liver &/or Wilson’s suspected or part of the differential in new liver dx
      • Long-term PO zinc administration or "denture adhesives containing zinc" may create copper deficiency due to inhibiting GI copper absorption -> MDS

_Potentially in the future, Zinc may be utilized across the board (if routine Copper levels are checked to avoid risk of Copper deficiency, vs. low-dose Copper provided with the Zinc supplementation, per some literature)_

Himoto et al., Nutrients 2018
Mohammed et al., NCP 2012
Vitamin D

- **Risks if not repleted adequately or timely**
  - Increased bone disease (osteoporosis, fractures)
  - Increased susceptibility to infections / eg. tuberculosis
  - Possibly increased rejection risk
  - Increased intestinal permeability (-> systemic inflammation)

- **Liver Pt specific issues:**
  - ALWAYS check Vitamin D 25-OH LEVEL and PTH all Pre’s / Post’s
  - Pre- and Post-OLT high risk 2/2 Vit D metabolism occurring partially in liver, high risk for malabsorption (esp: cholestatic liver disease), and steroid use
  - For Pre-OLT - lower efficacy of Hep C meds if Vitamin D was deficient, more effective if D wnl (prior). Also less conversion to HCC if D wnl
  - For Post-OLT - may be lower risk of organ rejection with adequate D

Grant, J Am Assoc Nurse Pract. 2017
Stokes, Liver Int. 2013
Vitamin D, Dosing Strategies

• Pre- & Post- Transplant Standard
  • If no renal issue/resolved (GFR > 35) with deficient D – Give D (type/dose pending per protocol) + Ca, + Mg, [+/-K2 per some lit]

• Pre- & Post- Transplant Standard (+Renal)
  • If +renal pts (acute/chronic; GFR < 35) - check PTH, and if not within goal parameters (based on CKD stage) then hold D until PTH at safe level
    • Giving Vitamin D, Calcium-based phosphorus binders/Calcium supplements -- may further suppress PTH, increasing Adynamic Bone Dz

Vitamin D deficiency is common even in the majority of the population: ALL! Also: genetic variance in Vitamin D receptors and Vitamin D binding proteins, may individualize dosing: still being elucidated in the research.

Grant, J Am Assoc Nurse Pract. 2017
Constantakis et al., Ann Gastroenterol 2016
### Overview + Additional Micronutrients to Consider

<table>
<thead>
<tr>
<th>Micronutrient Deficiency Management</th>
<th>In PRE &amp; POST - Liver Transplant – Micronutrient Repletion Dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamine Deficiency [TD]</td>
<td>500 mg IV thiamine TID x3 days -&gt; 250 mg IV thiamine 5 days -&gt; 100 mg PO thiamine TID ongoing through OLT or x 6 months post-OLT, then reassess</td>
</tr>
<tr>
<td>Zinc Deficiency</td>
<td>220 mg PO ZnSO4 daily (or 1 ml liquid) x 14-30 days, recheck 1 week later, if still deficient, redose &amp; check Copper levels – over-administration of PO zinc can block adequate copper absorption</td>
</tr>
<tr>
<td>Vitamin D Deficiency</td>
<td>50,000 IU D2 (Ergocalciflor) weekly, or 2,500-4,000 IU D3 (Cholecalciferol) daily, x 12 weeks, then reassess (See Liver / Intestinal Transplant Service Vitamin D / Bone Health Protocol for algorithm)</td>
</tr>
<tr>
<td>Copper Deficiency</td>
<td>2 mg IV x 5 days, if risk for Wilson’s disease has been ruled out via 24-hour Urinary Copper. (Note: some literature confirms Copper deficiency in overzinc-administered Wilson’s disease patients)</td>
</tr>
</tbody>
</table>

**Micronutrient Assessment Tips**

- For additional micronutrient deficiencies and their repletion strategies, please consult RD.

### Micronutrient Deficiency

- **In Fatty Liver**: High risk for Copper deficiency, mediated by gut microbiome alterations and high refined sugar and carbohydrate intakes; +/- PPI use, consult RD
- **In CRRT / TPN**: Add 100 mg IV thiamine daily, to compensate for losses, high utilization, and low enteral absorption rates in liver disease patients; consult RD
- **In Seizures**: Check to rule out Vitamin B6 deficiency; if deficient: 20mg IV Pyridoxine (Vitamin B6) x21 days then recheck and redose if still deficient; consult RD
- **In Anemia**: Check to rule out Iron, Folate, Vitamin B12, Copper RBC/Serum + Ceruloplasmin, Vitamin E, Vitamin B1/B6 deficiencies; consult RD
- **In Neuropathy**: Check to rule out Vitamin B12, Vitamin B6 (toxicity/deficiency), Vitamin B1, Vitamin E, Copper, Vitamin D, Folate deficiencies, Biotin (toxicity); consult RD
- **In Cytopenias/Pancytopenia**: Check to rule out Copper deficiency – Copper RBC/Serum + Ceruloplasmin, CRP, +/- 24hr Urinary Copper; consult RD for appropriate assessment and recommendations
- **In AMS / Hepatic Enceph.**: Check to rule out Thiamine (Vitamin B1), Vitamin B12, Zinc See repletion strategies above, vs consult RD

- For additional comorbidities with possible micronutrient deficiency involvement, please consult RD.

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**Recs:** Multivitamin WITHOUT Iron (Pre) + Minerals (Post)

**Plus repletion dosing for any deficiencies, until WNL**

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Grant, J Am Assoc Nurse Pract. 2017
Gerlach et al., JPN 2011
Aigner et al., Nature 2010
Mullin et al., GI and Liver Disease, 2012
Sriram et al., JPEN 2009
Where all the Liver Love happens... right up there at the top RIGHT! and in GOU-Obs!
EXTRAS ... 😊

(from Nursing Q’s...

...& RD A’s)
Which Diet Orders CAN be Combined / or not?

- Certain (more common) diet orders ARE ABLE to be combined (but we want to limit to like < 2-4 - if able)
  - 2gm Na, Carb Controlled, Low K+, 1000 mg PO4, Mechanical Soft
  - Fluid Restrictions

- Certain (i.e. ‘Regular’ or the more obscure) diet orders ARE NOT ABLE to be combined [except w/ Fluid Rest?]
  - Gluten Free
  - Vegan

- There are other diet orders as well, such as:
  - Low Fiber, Post Gastrectomy (used post MVT), Pediatric, Kosher
### Which TF for Multivisceral+Liver Tx Patients?

<table>
<thead>
<tr>
<th>Ordering Enteral Nutrition [EN] / Tube Feeding [TF]</th>
<th>In PRE &amp; POST – Intestinal/Multivisceral Transplant</th>
<th>Calories / Protein / Fat Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vivonex RTF</strong></td>
<td>May be started as initial elemental feeding transition, from PN to EN, post-intestinal transplant if desired per surgeon/Dr. Farmer. Or to establish gut tolerance in pre-intestinal/MVT who takes PO but is intubated in the ICU. Goal: to trickle/prime new gut or re-establish tolerance vs. meet estimated needs as very high volumes required</td>
<td>1.0 calories/ml, 50 grams protein/l; 40% MCT (Least concentrated; free amino acids)</td>
</tr>
<tr>
<td><strong>Peptamen AF</strong></td>
<td>Initial (less food antigen) hydrolyzed &amp; high protein, MCT&gt;LCT, limited CHO/osmol TF started after/+PN. Provides better lipid profile MCT &gt; LCT, and n-3 FA which may be advantageous for new bowel. Also: inflammatory bowel disease patients pre-intestinal/MVT, if intubated. Goal: high protein, low food antigen, reduce inflammation</td>
<td>1.2 calories/ml, 76 grams protein/l; 50% MCT+n-3 (Less concentrated, hydrolyzed protein)</td>
</tr>
<tr>
<td><strong>Peptamen with Prebio</strong></td>
<td>May be used in intestinal failure/pre-intestinal-MVT and post-intestinal/MVT patients with severely impaired GI function not tolerating the above or below formulas, contains soluble fiber, isotonic (300 mOsm/kg)</td>
<td>1.0 calories/ml, 40 grams protein/l; 70% MCT (Least concentrated; hydrolyzed protein)</td>
</tr>
<tr>
<td><strong>Peptamen 1.5 with Prebio</strong></td>
<td>May be used in post-intestinal/MVT patients if restricted volume formula needed; providing hydrolyzed protein (better absorbed), MCT &gt; LCT. Not appropriate if K+ elevated. Monitor tolerance to higher osmolality. Goal: more kcal, less volume, with improved absorption</td>
<td>1.5 calories/ml, 67.6 grams protein/l; 70% MCT (Semi-concentrated; hydrolyzed protein)</td>
</tr>
<tr>
<td><strong>Nepro</strong></td>
<td>Not ideal, given very high osmolality but may be indicated for pre/post-intestinal/MVT patients with high K+ / PO4 due to renal function, or medication-related elevations. Goal: minimize hyperkalemia, provide adequate protein</td>
<td>1.8 calories/ml, 81 grams protein/l; No MCT (Concentrated; standard/intact protein)</td>
</tr>
<tr>
<td><strong>Two Cal HN</strong></td>
<td>Typically too hyperosmolar for pre-/post-intestinal/MVT patients newly transplanted, but used if tolerated, later. Goal: high calorie/low volume intake, if gut tolerance intact.</td>
<td>2 calories/ml, 83.5 grams protein/l; No MCT (Most concentrated; standard/intact protein)</td>
</tr>
<tr>
<td><strong>MODULAR: Beneprotein</strong></td>
<td>Protein powder additive which can be used as:1 scoop BID, TID, or QID, mixed in 60-120ml free water slurry</td>
<td>25 calories/scoop, 6 grams protein/scoop</td>
</tr>
</tbody>
</table>

-Standard, intact, and insoluble fiber-containing formulas such as Osmolite and Jevity are typically not used due to poorer absorption and the need for a hydrolyzed protein (or elemental in some cases), and MCT > LCT containing formulas.

-Elevated Tbil >5 indicates high degree/risk of fat malabsorption, requiring medium chain triglyceride MCT > (long) LCT formulas.
Which PO Supplement for Bowel+Liver Patients?

<table>
<thead>
<tr>
<th>Ordering Oral Nutrition Supplements* [ONS]</th>
<th>In PRE &amp; POST - Intestinal Transplant</th>
<th>Calories / Protein</th>
<th>Flavors Available In-house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peptamen with Prebio</td>
<td>Appropriate for short gut, excessive malabsorption, poor ONS tolerance, and post-transplant with less food antigens</td>
<td>250 kcal, 10 grams protein</td>
<td>Vanilla</td>
</tr>
</tbody>
</table>

**Supplements high in potassium may need to be avoided at home in the early post-transplant period, 2/2 hyperkalemia/MI risk. Monitor.

Or, patients can also make their own, while admitted:

- Rice Milk
- Cinnamon
- Beneprotein

*Mix w/ plastic fork to make a paste w/ small amount of liquid, then add more, stir
Choose

- Plant-based fats: olive oil, avocado,* nuts* and seeds*, cold flaxseed oil, pure MCT oil or coconut oil in moderate amounts
- Omega 3 fatty acids: wild salmon, herring/sardines (3.5 oz. per week)
- Foods rich in soluble fiber (oats, barley, cooked dried beans*, and peas) and resistant starch (such as tigernuts - a newer food on the market that feeds healthy gut bacteria)
- Vegetarian proteins (beans/lentils*, nuts/seeds*, nut butters*)
- Eat a variety of fruits, especially dark berries, and more vegetables (2½ cups veggies daily!) Especially broccoli/cruciferous!
- Eat more plain yogurt* for healthy gut bacteria (can be non-dairy too) add flavor yourself (such as warmed frozen berries)
- Mix in a lot of anti-inflammatory spices, herbs, and roots (turmeric, ginger, Ceylon cinnamon)
- Regular coffee is okay (if okayed by your MD)

Avoid

- Inflammatory polyunsaturated vegetable oils (mostly all others except olive/avocado oils) & Trans-fats (partially hydrogenated oils found in many processed baked and fried foods)
- Saturated fats (butter, lard, ghee, cheese, cream) Note: some is okay/possibly beneficial if there is a history of alcoholism
- Low fiber processed foods and refined grains (white breads, pasta, rice, and snack foods)
- Red meats (beef, pork, lamb, bison/buffalo) Avoid shellfish & raw fish (vibrio risk)
- Processed meats (hot dogs, cured meats, deli/lunchmeat, and breakfast meats)
- Refined sugar (all sugars, high fructose corn syrup, agave and maple syrups, jelly/jam, sodas, candy) artificial sweeteners still affect glucose tolerance (so limit/avoid if able)
- Reduce intake of high heat oil-based sautéed, fried, or roasted, browned, and charred foods
- Avoid Alcohol-containing beverages & foods