ADULT NUTRITION SUPPORT HANDBOOK

Our Lady of the Lake Regional Medical Center

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ADULT NUTRITION SERVICES AT OLOL

DEPARTMENT OF NUTRITION SERVICES

Inpatient Clinical Nutrition Services:

The registered dietitians provide the following at Our Lady of the Lake (OLOL) Regional Medical Center:

- Assess nutritional status.
- Develop and implement a nutrition care plan tailored to the individual patient's needs.
- Follow-up with revision of care plan as needed to improve nutritional status, as well as nutrition counseling as needed.

Each patient unit has a designated dietitian and dietetic technician. We can be contacted by calling Nutrition Services Office at 5-8366 or 5-3041. A dietitian is available Monday through Friday between 7:00 a.m. - 5:00 p.m. Clinical staff is also here on the weekends and are on-call during after-hours. Please **CONSULT** nutritional services for nutritional needs!

DEPARTMENT OF PHARMACY SERVICES

Clinical pharmacists in collaboration with inpatient clinical nutritionists provide TPN management service for OLOL inpatients. Nutritionists recommend and manage the amount of macronutrients in the TPN while the clinical pharmacists monitor and adjust the electrolytes in the TPN.

Each patient care unit has a designated clinical pharmacist. A clinical pharmacist is on-call 24/7 and available in the hospital on weekends.

TPN Management Consult

Under 'General TPN' order set, Clinical Nutrition and Clinical Pharmacy services should be consulted simultaneously to manage the TPN using the 'Inpatient Consult to Nutrition Services' and 'Pharmacy to dose TPN' orders. When consulted, clinical nutritionists will recommend and manage the amount of macronutrients while clinical pharmacists will order the required labs and manage the amount electrolytes in the TPN.

When a patient on TPN has an enteral diet ordered, a calorie count will be ordered by the dietician or pharmacist in order to reduce inappropriate TPN/enteral nutrition overlap. If a patient remains on TPN despite tolerating 60% of their caloric needs via the enteral route, a discussion will be had with the physician who ordered the TPN regarding discontinuation.

NUTRITIONAL ASSESSMENT OF ADULT PATIENTS

INTRODUCTION

The purpose of nutritional assessment is to evaluate the patient's present nutritional status and to determine the presence of malnutrition or the risk of developing malnutrition. Since there is no single clinical or laboratory indicator of comprehensive nutritional status, an assessment includes the collection of data from a variety of sources including historical data, clinical signs/physical examination, anthropometrics, laboratory data, and functional domains.

ANTHROPOMETRICS

The most common anthropometrics used in the hospital setting are weight (wt), height (ht) and weight/height (wt/ht) and their comparisons to standard values.

A. Estimating ideal body weight (IBW) or desirable wt/ht (Hamwi Method):

Males: 106 # for the first 5 feet of ht plus 6 # for each additional inch (+/- 10%)

Females: 100 # for the first 5 feet of ht plus 5 # for each additional inch (+/- 10%)

B. Body Mass Index (BMI):

The Body Mass Index accounts for differences in body composition by defining the level of adiposity according to the relationship of weight to height and eliminates dependence on frame size. However, it does not account for muscle mass. For individuals with BMI ≥ 35, measure waist circumference.

BMI = wt (in kilograms)/ ht (in meters)^2 or wt (in pounds)/ ht (in inches)2 x 705

BMI Classification	BMI (kg/m2)	Disease Risk	Disease Risk with Abdominal Obesity
Underweight	< 18.5 kg/m^2		Not applicable
Normal weight	18.5-24.9 kg/ m^2		Normal risk
Overweight	25-29.9 kg/ m^2	Increased	High
Obesity (Class 1)	30-34.9 kg/ m^2	High	Very High
Obesity (Class 2)	35-39.9 kg/ m^2	Very High	Very High
Extreme obesity (Class 3)	> 40 kg/ m^2	Extremely High	Extremely high

**Adopted from the Academy of Nutrition and Dietetics*

NUTRITIONAL INTAKE HISTORY:

A history of food intake is usually obtained by one of the following:

- 24 hour recall
- 3 day food record

Data collection should include:

- Food habits
- Quality and quantity of ingested nutrients
- Appetite and changes in appetite
- Food intolerance and allergies
- Chewing or swallowing problems

LABORATORY DATA:

There is currently no reliable, valid biomarker of nutrition status. Lab values are helpful in the assessment of nutritional status; they should be used in combination with other clinical data, and no one value should be considered as a predictor of nutritional status. Research has shown that hepatic proteins are not reliable indicators of nutritional status and are negative acute phase reactants.

REFEEDING SYNDROME:

Refeeding syndrome refers to the metabolic and physiologic changes that occur upon aggressive nutrition support or repletion of a malnourished patient. Patients at risk include (but not limited to): chronically malnourished, chronic alcoholism, prolonged NPO status with stress for 7-10 days, malabsorption syndromes, oncology patients, uncontrolled diabetes, and weight loss of 5-10% in 1 to 2 months.

Clinical presentation includes tachycardia, SOB, extracellular fluid retention related to hypoalbuminemia and sodium balance, increased respirations with respiratory failure, weakness, numbness, confusion, cardiac decompensation, tetany, seizures, coma, and death. Biochemical abnormalities include hypophosphatemia, hypokalemia, hypomagnesemia, hyperglycemia, fluid overload, sodium retention, and thiamine deficiency. Treatment includes correcting electrolytes before feeding, initiating hypocaloric support with full protein support while restricting fluid, sodium, and supplementing thiamine.

NUTRITIONAL REQUIREMENTS:

Nutritional requirements for adults should be estimated on an individual basis. The nutritional requirements of each patient will depend upon a number of factors including:

- Age
- Activity level
- Current nutritional status
- Current metabolic and disease states
- Individualized goals

The following section will provide a brief overview of the determination of nutritional requirements including calories, protein and fluid for the hospitalized patient.

Calorie Requirements:

Estimating energy expenditure in hospitalized adult patients is challenging. If available, indirect calorimetry can be used to measure energy expenditure. Frequent measurements are required to appropriately identify a patient's energy expenditure. When indirect calorimetry is not possible, using energy equations (i.e. Harris-Benedict, Penn State, etc.) or kcal/kg in the interim are necessary.

Calorie Requirements in Most Hospitalized Patients

Adults (18-65)	20-30 kcal/kg
Elderly (65+)	~25 kcal/kg
Obese or Super obese	15-20 kcal/kg AdjWt

**Calorie requirements may vary based on degree of stress and need for repletion*

Clinical judgment should be used to individualize each patient's estimated needs, and frequent monitoring and evaluation of nutrition interventions should occur to make adjustments as needed based on patient response.

Metabolic cart:

Indirect calorimetry using a "metabolic cart" measures actual energy expenditure by collecting, measuring and analyzing the oxygen consumed (VO2) and the carbon dioxide (VCO2) expired. From these measurements the respiratory quotient (RQ) is calculated. The RQ for carbohydrate, protein, and fat differs and reflects net substrate utilization at the time of measurement. However, one of the requirements is that the patient has to be intubated for the test to be performed.

Protein Requirements:

SUGGESTED PROTEIN GUIDELINES IN ADULT HOSPITALIZED PATIENTS

Clinical condition	Protein requirement
Mild stress	1.0 – 1.2 g/kg
Moderate stress	1.5 – 2.0 g/kg
Severe Obesity	1.5 g / kg AdjWt – 2.0 g/kg IBW
Severe stress	2.0 –2.5 g/kg
Chronic renal failure, no dialysis	0.8-1.3 g/kg *
Hemodialysis	1.2 – 1.4 g/kg

**Protein needs may be higher if the patient is critically ill*

Fluid Requirements:

Fluid requirements will vary among patients and may increase or decrease from normal needs under a number of conditions.

ESTIMATING ADULT FLUID REQUIREMENTS

i) **By caloric intake: 1ml / calorie**

ii) **By body weight and age:**

Adults Age	Fluid
18 – 55	35 ml per kg body weight
55 – 75	30 ml per kg body weight
75 years and older	25 ml per kg body weight
Fluid restriction (renal and cardiac disease, fluid overload states)	≤ 25 ml per kg body weight

When determining total fluid intake of the tube fed patient, the amount of free water in the tube feeding formula and intravenous fluids needs to be considered. Intake and output records should be monitored as well as weight. A rapid weight gain or loss of 1 kg may be the result of a fluid gain or loss of 1 liter.

ENTERAL NUTRITION (EN)

INTRODUCTION

The gastrointestinal (GI) tract is the most effective way to feed the patient. Enteral nutrition (EN) is defined as nutrition provided through the GI tract via a tube, catheter or stoma that delivers nutrients distal to the oral cavity. EN is the preferred method of feeding those patients unable to meet their nutrition needs by mouth. EN utilizes the normal route of digestion and absorption of the GI tract and supports maintenance of the functional integrity of the gut. OLOL has dietitians that specialize in nutrition support CONSULT the Nutrition Support Team for a dietitian to assess and implement tube feeding orders.

A. Benefits of Enteral Nutrition (compared with Parenteral Nutrition)

- Supporting the components of gut barrier function
- Efficient utilization of nutrients as they undergo first-pass metabolism
- The presence of nutrients in the small intestine maintains normal gallbladder function, reducing the risk of cholecystitis that may occur with TPN.
- Luminal nutrients provide structural support and aid in maintaining immune function.
- Reduce infectious complications associated with pneumonia, sepsis, IV line sepsis, and intra-abdominal abscess.
- Less expensive than TPN.
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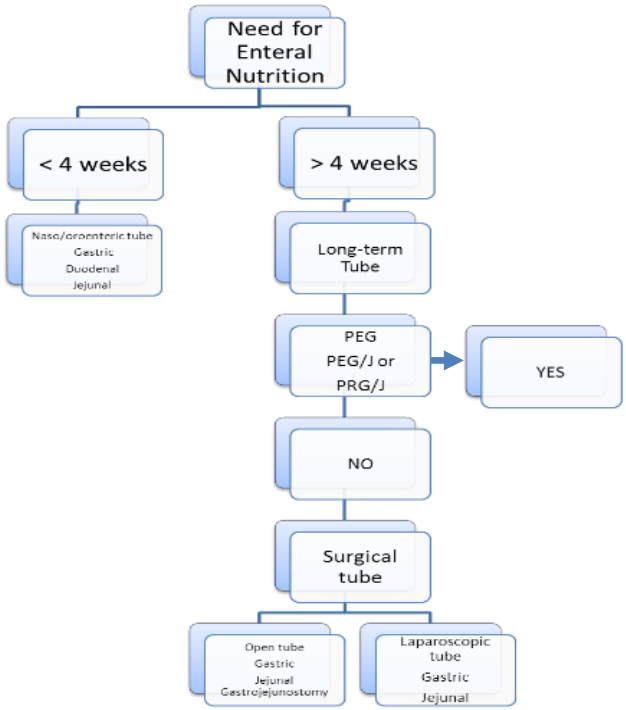
B. Enteral Access Decision Tree



OLOL Enteral Nutrition Formulary

Category	**High Protein w/fiber**	**Concentrated Calories w/fiber**	**Very High Protein w/fiber**	**Calorie and Protein Dense**	**Diabetes**	**Diabetes**	**Renal (Dialysis)**	**Metabolic Stress**	**Peptide-Based Elemental, High Protein**	**Immune Support**
Product	Jevity 1.2	Jevity 1.5	Promote w/fiber	TwoCal HN	Glucerna 1.2	Glucerna 1.5	Nepro	Perative	Vital AF 1.2 Cal	Pivot 1.5
Nutrient Values per	1 L	1 L	1 L	8 fl oz	1 L	1 L	1 L	1 L	1 L	1 L
Kcal/ml	1.2	1.5	1.0	2.0	1.2	1.5	1.8	1.3	1.2	1.5
Protein (g)	55.5	63.8	62.5	19.9	60	82.5	81	66.7	75	93.8

OLOL Early Enteral Feeding Protocol

At OLOL there is the early enteral feeding protocol for the intensive care units. This allows the physician to order an early enteral feeding and consult the dietitian to assess the patient and modify enteral feedings. The protocol is as follows:

- ✓ Elevate head of bed 30 degrees. Place a sign over the bed that reads:

  "KEEP HEAD OF BED ELEVATED 30 DEGREES"
- ✓ Tubes (Enteral Feeding tube type to be specified by physician)
  - Nasogastric tube
  - Duodenal tube
  - Feeding

CONTINGENCY

- ✓ Notify: MD of high residual (greater than 400ml) without distention or pain, nausea and/or vomiting, abdominal

C. Residual Checks

Do not check residuals with post-pyloric feeding tubes.

Per ASPEN inappropriate cessation of EN should be avoided. Holding EN for gastric residual volumes <500 ml in the absence of other signs of intolerance should be avoided.

Monitoring of Enteral Nutrition

Preventing Complications

Continued monitoring of nutritional intake is particularly important for patients receiving enteral nutrition support in order to identify inadequacies before deficiencies develop. Recommendations for changing or supplementing nutritional support are based on accurate and timely documentation of delivery.

Patients on nutrition support also need to be closely monitored to ensure that energy needs are being met but not exceeded. Overfeeding can cause a number of complications which may prevent clinical improvement. Prolonged underfeeding may lead to loss of lean tissue, skin breakdown, inadequate wound healing and immune dysfunction.

Use of Blue Dye

In the past, blue dye or food coloring was sometimes added to tube feedings as an indicator of aspiration. This practice has not been shown to be an effective method to monitor for or prevent aspiration pneumonia. In addition, studies have shown that critically ill patients may have increased gut permeability, making them susceptible to absorption of the dye into systemic circulation. When absorbed, blue food dye can act as a mitochondrial toxin causing unfavorable outcomes, up to and including death. OLOL Nutritional Services do NOT use blue dye per policy.

Drug Nutrient Interactions with Enteral

Medications are often administered through enteral feeding tubes. Information concerning drug-nutrient interactions during enteral feedings is limited, particularly regarding bioavailability and absorption. Medications given by the enteral route (bypassing the usual location of absorption) may cause what appears to be formula intolerance and/or result in less than optimal drug absorption. General guidelines for administering medications with tube feedings are as follows:

- Stop the tube feeding prior to administration of meds.
- Flush the feeding tube with warm water before and after giving meds.
- Restart tube feeding when done giving meds.

PARENTERAL NUTRITION (PN)

INTRODUCTION

Parenteral nutrition (PN) support is used to nourish patients who either are already malnourished or have the potential for developing malnutrition and who are NOT candidates for enteral support. Parenteral nutrition provides intravenous carbohydrates in the form of dextrose, protein in the form of amino acids, lipids in the form of triglycerides, and vitamins, minerals, trace elements and fluid.

Peripheral Parental Nutrition (PPN)

Peripheral Parenteral Nutrition is defined as supplementation via a peripheral vein and is a temporary route for the administration of dilute nutrient solutions. Sensitivity of peripheral veins to hypertonic solutions limits the caloric density of formulations that may be used. Solutions with an osmolality of greater than 900 mOsm/L generally require central access.

At OLOL the standard PPN solution is Clinimix-E 4.25% (Quickmix), which provides 340 calories and 42.5g protein per liter. Additional formulations may be available such as: Clinimix 5% amino acid/ 15% dextrose with and without electrolytes. However, these formulations require use of a central line due to higher osmolarity.

<u>PPN is used only for a short time (up to 2 weeks) because:</u>

- The lack of peripheral venous sites that can withstand long-term high osmolality infusion
- May not meet patient's calorie and protein needs

<u>Indications:</u>

PPN may be used in the following conditions:

- Partial or total nutrition support for patients who are not able to ingest adequate calories orally or enterally, and whose therapy is likely to be less than 7 days.
- When central-vein parenteral nutrition is not feasible or desirable

<u>Contraindications:</u>

Because of the lower concentration of nutrients, PPN is not the optimal choice for feeding patients with the following conditions:

- Large electrolyte needs
- Fluid restriction
- The need for prolonged intravenous nutrition support
- Significant malnutrition
- Severe metabolic stress
- Renal or liver compromise

The following are cautions and contraindications for commercial PPN agreed upon by pharmacy and the clinical dieticians at OLOLRMC:

Caution:

1) GFR or CrcL <60 mL/min
2) Scr ≥ 2x baseline

Avoid:

1) ESRD
2) GFR or CrcL <30 mL/min
3) Scr ≥ 3x baseline or Scr >4 mg/dL
4) Renal replacement therapy
5) Electrolyte abnormalities including:
    a. Hyperkalemia with K >5
    b. Hypermagnesemia with Mg >3
    c. Hyperphosphatemia with PO4 >5

Clinimix

Clinimix is the preferred formulation for **Peripheral Parenteral Nutrition (PPN)** at **OLOLRMC**. Physicians frequently have questions about the amount of various electrolytes and the calories provided by **Clinimix.**

Each liter of Clinimix-E 4.25% provides 340 calories and contains the following ingredients:

Amino Acids	42.5 gm
Dextrose	50 gm
Sodium	35 mEq
Potassium	30 mEq
Chloride	39 mEq
Acetate	70 mEq
Calcium	4.5 mEq
Magnesium	5 mEq
Phosphate	15 mMols

Each liter of Clinimix- E 5/15 provides the following:

Amino Acids	50 gm
Dextrose	150 gm
Sodium	35 mEq
Potassium	30 mEq
Chloride	39 mEq
Acetate	80 mEq
Calcium	4.5 mEq
Magnesium	5 mEq
Phosphate	15 mMols

Note: We also carry some versions of Clinimix products WITHOUT electrolytes if necessary listed as Clinimix 4.25/5 or Clinimix 5/15 without the “E” for example. These may be recommended when needing to avoid electrolytes secondary to lab abnormalities and can be discussed with the provider and/or dietician.

The amount of electrolytes and calories provided by **Clinimix** will depend on the rate at which **Clinimix** is being infused.

Example:

What is the amount of each electrolyte and the total calories provided by Clinimix-E 4.25% if it is being infused at 100 ml/hour?

At 100 ml/hour, patient is receiving 2400 ml of Clinimix per day. Therefore, the patient will receive the following amount of electrolytes and calories per day.

Sodium	35	mEq / L	x 2.4	=	84	mEq
Potassium	30	mEq / L	x 2.4	=	72	mEq
Magnesium	5	mEq / L	x 2.4	=	12	mEq
Calcium	4.5	mEq / L	x 2.4	=	10.8	mEq
Phosphate	15	mMol/L	x 2.4	=	36	mMol
Chloride	39	mEq / L	x 2.4	=	93.6	mEq
Acetate	70	mEq / L	x 2.4	=	168	mEq
Amino acids	42.5	grams	x 2.4	=	102	grams
Dextrose	50	grams	x 2.4	=	120	grams
Total calories	340	per liter	x 2.4	=	816	calories

Total Parental Nutrition (TPN)

Total Parenteral Nutrition is defined as delivery of nutrients via central venous access. TPN allows for the provision of nutrients in greater concentrations and smaller fluid volumes than is possible with PPN. At OLOL TPN solutions are provided as 3-N-1 which means that all macronutrients (dextrose, amino acids, and lipids) are in one bag.

<u>CLINICAL INDICATIONS FOR PARENTERAL NUTRITION:</u>

i. **Parenteral nutrition is usually indicated in the following situations:**

- Documented inability to absorb adequate nutrients via the gastrointestinal tract; this may be due to:
  - Massive small-bowel resection / Short bowel syndrome (at least initially)
  - Radiation enteritis
  - Severe diarrhea
  - Steatorrhea
- Complete bowel obstruction, or intestinal pseudo-obstruction
- Severe catabolism with or without malnutrition when gastrointestinal tract is not usable within 5-7 days
- Inability to obtain enteral access
- Inability to provide sufficient nutrients/fluids enterally
- Pancreatitis in the setting of intolerance to jejunal delivery of nutrients
- Persistent GI hemorrhage

- Acute abdomen/ileus
- Lengthy GI work-up requiring NPO status for several days in a malnourished patient
- High output enterocutaneous fistula and EN access cannot be obtained distal to the site
- Trauma requiring repeat surgical procedures / NPO status
- Patient has failed the EN trial with postpyloric tube placement

ii. **Parenteral nutrition *may* be indicated in the following situations:**

- Enterocutaneous fistula as above
- Inflammatory bowel disease unresponsive to medical therapy
- Hyperemesis gravidarum when nausea and vomiting persist longer than 5 -7 days and enteral nutrition is not possible
- Partial small bowel obstruction
- Intensive chemotherapy / severe mucositis
- Major surgery/stress when enteral nutrition not expected to resume within 7-10 days
- Intractable vomiting and jejunal access is not possible
- Chylous ascites or chylothorax when EN (with a very low fat formula) does not adequately decrease output

iii. **Contraindications for Parenteral Nutrition:**

- Functioning gastrointestinal tract
- Treatment anticipated for less than 5–7days in patients without severe malnutrition
- Inability to obtain venous access
- A prognosis that does not warrant aggressive nutrition support
- When the risks of PN are judged to exceed the potential benefits

COMPONENTS OF PARENTERAL NUTRITION

Macronutrients

Carbohydrate – Dextrose contains 3.4 kcal/g

Maximum rate of administration: 5 mg/kg/minute (GIR):

Commercially prepared dextrose solutions are available in concentrations ranging from 5% - 70%. D70W is used at OLOL. Solutions with final concentrations greater than 10% must be administered into a central vein because of the high osmolality.

Protein – Amino acid = 4 kcal/g

Protein calories should be included when calculating total caloric requirements. Crystalline amino acids are currently the protein source for commercial formulas. Amino acids are available in concentrations of 3 – 15% (10% amino acids – Used at OLOL).

Recommended Dose: 1.0 – 1.5g/Kg non stressed, 1.5 – 2.0g/Kg stressed

Lipids (Fat) – Intralipid – 20% lipid (2 kcal/ml) is used at OLOL.

IV lipids are also referred to as IV fat emulsions (IVFE)

Lipids should be used with caution in patients with serum triglycerides (TG) > 400mg/dl. Propofol is a lipid-based sedative (soybean oil-in-water emulsion) that contains phosphorus and provides 1.1 kcal/ml.

Micronutrients:

Vitamins – Parenteral vitamin requirements differ from enteral requirements because of differences in efficiency of absorption and utilization of nutrients administered via the parenteral route, and physiochemical stability in the parenteral solutions.

Composition of Adult MVI per 10 ml

Vitamin	Amount per 10 ml
Ascorbic acid (Vitamin C)	200mg
Vitamin A* (as palmitate)	3,300 IU
Vitamin D_3* (cholecalciferol)	200 IU
Thiamine (Vitamin B_1)	6mg
Riboflavin (Vitamin B_2)	3.6mg
Pyridoxine HCL (Vitamin B_6)	6mg
Niacinamide	40mg
Dexpanthenol	15mg
Vitamin E*	10 IU
Vitamin K_1*	150mcg
Folic acid	600mcg
Biotin	60mcg
Vitamin B_{12}	5mcg

Micronutrients:

Trace Elements – are critical to support proper function of metabolic pathways.

Daily Parenteral Trace Element Supplementation for Adults

Trace Element	Recommendations
Zinc	2.5 – 5 mg
Copper	0.3 – 0.5 mg
Chromium	10 – 15 mcg
Manganese	60 – 100 mcg
Selenium	20 – 60 mcg

Composition of MTE-5 (per mL) --3mL added to adult TPN

Trace Element	Amount per ml
Zinc	5mg
Copper	1mg
Manganese	0.5mg
Chromium	10mcg
Selenium	60mcg

Addition of Insulin to the TPN admixture:

Hyperglycemia is one of the most common metabolic complications seen in patients receiving TPN. When the serum blood glucose stays above 200 mg/dl, patients can benefit from administration of subcutaneous insulin given as sliding scale or addition of insulin to the TPN. Only regular insulin can be added to the TPN. It is reasonable to add 0.1 unit of regular insulin for each 1 gram of dextrose initially and then increase the amount based on patient response.

Use of Insulin sliding scale, as well as the addition of insulin to the TPN and subsequent adjustment in the amount of insulin in the TPN will require a physician's order.

Electrolytes:

Electrolyte requirements in TPN can vary widely. Ongoing GI losses, increased output from NG tube and surgical drains as well as diuretic therapy can increase electrolyte requirements.

Daily Electrolyte Requirements

Electrolyte	Parenteral
Sodium	1-2 mEq/kg
Potassium	1-2 mEq/kg
Chloride	As needed to maintain acid-base balance
Acetate	As needed to maintain acid-base balance
Calcium	10-15 mEq
Magnesium	8-20 mEq
Phosphate	20-40 mmol

Normal laboratory values:

	Normal serum range	Critically high value	Critically low value
Sodium	136 to 145 mEq/L	>159 mEq/L	< 121 mEq/L
Potassium	3.5 to 5.1 mEq/L	> 5.9 mEq/L	< 2.6 mEq/L
Chloride	100 to 109 mEq/L	> 41 mEq/L	<15 mEq/L
Bicarbonate	22 to 33 mEq/L		
Calcium	8.8 to 10.6 mg/dl	>11.9 mg/dl	<6.6 mg/dl
Magnesium	1.6 to 2.6 mg/dl		
Phosphorus	2.3 to 4.7 mg/dl		
BUN	5 to 25 mg/dl	>99 mg/dl	
Serum creatinine	0.57 to 1.25 mg/dl		
Glucose	70 to 100 mg/dl	>399 mg/dl	<51 mg/dl
Anion Gap	8 to 16		
Total Bilirubin	0.2 to 1.2 mg/dl		
Alkaline Phosphate	40 to 150 units/L		
ALT	5 to 50 units/L		
AST	10 to 58 units/L		
Serum Albumin	3.5 to 5 gm/dl		
Total protein	6 to 8.3 gm/dl		
Triglycerides	0 to 149 mg/dl		

Guidelines for intravenous (IV) electrolyte replacement:

These guidelines are recommended for patients with normal renal function. Patients with renal impairment should receive 50% of the initial empirical dose. If the patient is a dialysis patient, electrolyte replacement should be discussed with the nephrologist.

Empirical treatment of Hypokalemia

Serum potassium in mEq/L	IV potassium dose in mEq.
3 to 3.4	20 to 40
2.5 to 2.9	40 to 80
<2.5	80 to 120

Empirical treatment of Hypomagnesemia

Serum magnesium in mg/dl	IV Magnesium Sulfate dose
1 to 1.5 (Mild)	8 to 32 mEq (1 to 4 gm)
<1 (Severe)	32 to 54 mEq (4 to 8 gm)

Empirical treatment of Acute Hypocalcemia

Total serum calcium in mg/dl	IV calcium gluconate dose
<8.6 mg/dl	2 gm over 2 hours
<7.5 mg/dl	4 gm over 4 hours

Equation for corrected total calcium for hypoalbuminemia:

Corrected Total Calcium (mg/dl) = Measured Total calcium in mg/dl + 0.8 x (4 – serum albumin in g/dl)

Empirical treatment for Hypophosphatemia

Serum phosphorus in mg/dl	IV Phosphorus dose in mMol / kg
2.3 to 2.7 (Mild)	0.08 to 0.16
1.5 to 2.2 (Moderate)	0.16 to 0.32
<1.5 (Severe)	0.32 to 0.64
Each ml of sodium phosphate equals 4 mEq sodium and 3 mMols phosphorus	
Each ml of potassium phosphate equals 4 .4 mEq potassium and 3 mMols phosphorus	

Recommended daily electrolyte quantities to be added in adult TPNs:

For patients with normal renal function and serum chemistry, it is recommended that the TPN should provide the following quantities of electrolytes daily:

Electrolytes	Recommended daily amount per TPN bag
Sodium	80 mEq
Potassium	20 to 40 mEq
Magnesium	4 to 12 mEq
Phosphorus	10 to 15 mMol
Calcium	5 to 10 mEq
Chloride	For metabolic acidosis, minimize the amount of chloride
Acetate	For metabolic alkalosis, minimize the amount of acetate

Electrolyte requirements can vary widely depending upon various factors as listed below:

GI losses – vomiting, diarrhea and losses from NG suction
Refeeding syndrome
High output from surgical drains, fistulas
Use of diuretics
Compromised renal function

Careful consideration should be given to the patient's overall clinical situation before making adjustments to the electrolytes in the TPN.

When pharmacy is adjusting electrolytes in the TPN, the following guidelines should be followed:

Electrolyte	Maximum daily amount in the TPN
Potassium	120 mEq
Magnesium	24 mEq
Phosphorus	45 mMols
Calcium	18 mEq (4 gms)

If patient's electrolytes requirements exceed the limits mentioned above, physician should be contacted before increasing the electrolyte amount.

Stability and Compatibility of TPN admixtures

Parenteral nutrition admixtures are prone to problems with stability and compatibility of components.

Factors influencing stability and compatibility include temperature, pH, concentration of ingredients and length of time between compounding and administration.

The most common compatibility problem is the precipitation of calcium and phosphorus which can be life threatening. The risk of precipitation is increased by the following factors:

- High concentration of calcium and phosphorus salts
- Decreased amino acid concentration
- Increased temperature of TPN admixture
- Use of chloride salt of calcium
- Increased pH of the admixture
- Improper mixing sequence of calcium and phosphorus salts

Determination of Calcium and Phosphorus Solubility and Precipitation for adult TPNs

Calculation:

1. Determine the total volume of TPN by adding up the amount of amino acid solution, Dextrose, Lipids and standard electrolytes if amino acids with electrolytes is ordered.

2. Find the total amount of Phosphorus in the TPN by adding the amount of phosphorus in the standard electrolyte solution AND the amount of phosphorus added as either Sodium phosphate or Potassium phosphate, in addition to the standard electrolyte solution. Phosphorus should be expressed in milliMols.

3. Find the total amount of calcium in the TPN by adding the amount of calcium in the standard electrolyte solution AND the amount of calcium gluconate added in addition to the standard electrolyte solution. Calcium should be expressed in milliequivalents.

4. Multiply the total amount of phosphorus in the TPN by 2

5. Add the numbers from step 3 and 4

For every 1000 ml of TPN the product of calcium and Phosphorus should be 45 or less.

Calculation of Calcium - Phosphorus Precipitation ratio:

Example: Calculate the Calcium - Phosphorus solubility for the following TPN

Amino acids	1000 ml
Dextrose 70%	380 ml
Lipids 20%	250 ml
Sodium Chloride	30 mEq
Sodium phosphate	30 mMols
Potassium Chloride	20 mEq
Potassium Phosphate	15 mMols
Calcium gluconate	20 mEq
Magnesium Sulfate	8 mEq
MVI	10 mll
MTE-5	3 ml

Total TPN volume = 1700 ml (amino acids, dextrose, lipids and electrolytes)

Total amount of phosphate = 45 mMols
Total amount of calcium = 20 mEq
Total amount of phosphate X 2 = 45 mMols X 2 = 90 mMols

Add total Ca and Phosphate = 90 + 20 = 110

For 1000 ml of TPN, the calcium – phosphorus product should not exceed 45

For 1700 ml of TPN the Calcium-Phosphorus precipitation product should not exceed 76

At 110, this TPN exceeds the solubility breakpoint for calcium and phosphorus, and should not be compounded as ordered.

Monitoring parameters for adult patients receiving TPN

When patients are started on TPN, the following monitoring protocol will be implemented:

- TPNs will be infused at 24 hours rate
- Daily weights
- Strict I and O
- Bedside glucose every 6 hours and PRN
- Baseline Chem-7, calcium, magnesium, phosphorus and triglyceride level
- Chem-7, calcium, magnesium, phosphorus every Monday / Thursday thereafter
- Total bilirubin, Alkaline phosphate, AST, ALT, prealbumin, transferrin and triglycerides every Monday
- Chem-7, calcium, magnesium and phosphorus levels as needed.

*Please use the EPIC 'General TPN; order set to order the appropriately required labs

**Note: For hepatic labs, use the 'hepatic function panel' lab instead of needing to order total bilirubin, alkaline phosphatase, AST, ALT separately.

Elements of TPN progress notes for clinical pharmacists:

Clinical pharmacists will leave a progress note in patient's medical record after initiating the new TPN order and with each subsequent electrolyte adjustment.

The progress note will include the following:

- Indication for TPN
- AM labs
- Amount of each electrolyte provided by the existing TPN
- Any electrolyte riders patient may have received in the previous 24 hours
- Any maintenance IVF and hourly rate
- Ongoing orders for potassium and magnesium replacement riders for ICU patients
- Amount of each electrolyte provided by the new TPN highlighting the changes from previous TPN
- Any new labs ordered for the next day

Standard TPN Hang time policy at OLOLRMC:

- TPNs will be hung at **2000** for all adult patients
- Electronic orders via CPOE and written orders for TPN must be entered/scanned to pharmacy by **1300**
- If a new TPN order is not sent to pharmacy by **1300**:
    - An order must be obtained from the physician for either Dextrose 10% or Clinimix and the new TPN will be made the following day and hung at **2000**
- If changes to an existing TPN are not sent to pharmacy by **1300**, the physician must order Dextrose 10%, Clinimix, or another replacement fluid until the new bag is prepared and hung the following day at **2000**

A TPN bag should **never hang for >24 hours** due to the risk infection.

Documentation and tracking patient progress:

Clinical pharmacists managing the TPN will initiate and maintain a TPN tracking form to serve as a documentation tool for monitoring the patients receiving TPN and to facilitate continuity of care.

Daily laboratory parameters as well as the composition of the TPN admixture will be documented on this form daily until the patient is no longer receiving TPN.

Copy of the form is attached on the next page of this document.

Our Lady of the Lake RMC
Clinical Pharmacy
Adult Parenteral Nutrition Tracking Form

Name:
MRN:
DOB:
Location:

Patient Information:		
Age:	Sex:	M / F
Weight (kg):	Height (in):	
Allergies:		
Central Access:	Refeeding Risk ☐	

Consult Information:	
Date:	
Ordering Physician:	
Attending:	
Home PN Provider:	
Hemodialysis ☐	At Goal Calories ☐

PMH/HPI:

Date							
Na							
K							
Cl							
CO_2							
BUN							
SCr							
Glu							
Ca							
Ca^{++}/Corr. Ca							
Tbili							
Albumin							
AST							
ALT							
Mg							
PO_4							
TG							
Prealbumin							
Accuchecks							
I&O							
Insulin							
K Rider							
Mg^{2+} Rider							
PO_4 Rider							

Our Lady of the Lake RMC
Clinical Pharmacy
Adult Parenteral Nutrition Tracking Form

Name:
MRN:
MD:
Location:

Product	Daily Requirements							
Amino acid 10% (g)	0.8-2.5g/kg/day							
Dextrose 70% (g)	70-80% NP kcal/day							
Fat emulsion 20% (g)	15-30% NP kcal/day							
Sodium acetate (mEq)	1-2 mEq/kg/day (total Na^+)							
Sodium chloride (mEq)								
Sodium phosphate (mmol)	20-40 mmol/day (total Phos)							
Potassium acetate (mEq)	1-2 mEq/kg/day (total K^+)							
Potassium chloride (mEq)								
Potassium phosphate (mmol)	20-40 mmol/day (total Phos)							
Calcium gluconate (mEq)	10-15 mEq/day							
Magnesium sulfate (mEq)	8-20 mEq/day							
MVI-12 (mL)	10 mL/day							
Trace elements (MTE-5)	3 mL/bag							
Regular insulin (units)	0.05-0.1 units/g Carbs							
Thiamine (100mg/mL)	100 mg/bag							
Folic Acid (5mg/mL)	1mg/bag							
Sterile water	30mL							
Other Additives:								
Total volume (mL):								
Infusion rate (mL/hr):								
Cyclic TPN (hours):								
Total Sodium (Fraction NS)	Not to exceed (NTE): NS							
Total Potassium (mEq)								
Ca/Phos Ratio	NTE: 45meq/L							
GIR (mg/kg/min)	NTE: 5mg/kg/min							
Initials:								

Date	Notes

TPN Checklist for Adult Patients:

Checklist for starting a new TPN:

- Check if patient has a central catheter
- Check for nutritionist's recommendations on macronutrients
- Review labs from the am. If no new labs, then order stat chem-7, calcium, magnesium, phosphorus, TG, hepatic function panel
- Review the trend in serum chemistry over the last few days before determining the amount of electrolytes added to the TPN
- Check if patient has significant output from NGT or surgical drains and fistulae
- Check if patient is on IVF --- if yes, which IVF and at what rate -- check with MD if any change in the IVF rate is warranted after starting the TPN
- Check if patient is on diuretics
- Check if any electrolyte riders have been ordered to correct low electrolyte values
- Make sure that accuchecks have been ordered
- Make sure the calcium-phosphorus precipitation ratio is in desired range
- Double check the TPN CPOE for accuracy before signing the order
- Order appropriate labs for the next am if necessary and as per TPN protocol
- Accurately document the lab values and the TPN admixture composition on the TPN monitoring form

Checklist for TPN follow up:

- Check the TPN hang time from the previous day
- Review the am labs to determine if electrolyte adjustment is needed
- Contact MD if riders need to be ordered for emergent correction of electrolytes
- Check if patient has new orders for diuretics
- Check if patient has significant output from NGT or surgical drains and fistulae
- Check the accucheck BG readings as well as the amount of insulin given from the sliding scale to determine if insulin can be added to the TPN
- If changes are made to the TPN, double check the CPOE for accuracy
- Order appropriate labs for the next am if necessary
- Accurately document the lab values and the TPN admixture composition on the TPN monitoring form

Cyclic TPNs

Occasionally, cyclic TPNs may be ordered or requested by a provider. A cyclic TPN is a TPN that is infused over a shorter period of time < 24 hrs (usually 8-14 hrs for example). This allows for an off period, which can reduce risk of liver complications, including parenteral nutrition-associated liver disease (PNALD). Cyclic TPNs can also improve patient satisfaction by allowing for increased mobility in patients that will be on long-term TPN without having to be attached to an IV pole.

Cyclic TPNs must be entered differently than a traditional TPN. You may still use the same 3-in-1 TPN order in the EMR. However, a separate cyclic 3-in-1 template is used in the Abacus software. Once a cyclic infusion mode is selected, the pharmacist must set a cyclic sequence that includes a ramp up and ramp down period (usually a one hour ramp up and ramp down at half the maintenance rate) to reduce the risk of hyper- and hypoglycemia. Of note, cyclic TPNs provide a larger amount of nutrients over a shorter period of time so considerations such as glucose infusion rate (GIR) must be taken into account not to exceed the max infusion rate.

An example wording that should be included in EMR administration instructions is as follows (can use ".CYCLICTPN" smart phrase:

Infuse TPN over a total of *** hours per day.
Start at *** mL/hr for the first hour.
Increase to *** mL/hr for *** hours.
Decrease to *** mL/hr for the last hour.
No additional TPN to be infused for remainder of the day.

Example: MD wants cyclic TPN over 12 hrs with a total TPN volume calculated to be 2400 ml/day.

Infuse TPN over a total of 12 hours per day.
Start at 110 mL/hr for the first hour.
Increase to 218 mL/hr for 10 hours.
Decrease to 110 mL/hr for the last hour.
No additional TPN to be infused for remainder of the day.

Step 1: Figure out total hours TPN to be infused over

Ex. 12 hrs

Step2: Figure out maintenance rate using "total volume/ (total time -1)"

Ex: 2400 ml / 11 = ~218 ml/hr

Step 3: Maintenance rate hours set to be "total time -2"

Ex: 12 hrs -2 = 10 hrs

Step 4: Calculate ramp up and ramp down rates, which should be roughly 50% of the maintenance rate

Ex: 218/2 = 109 ml (but using 110 ml) so that total ml/bag will equal exactly 2400 ml/day

Step 5: Re-check work by adding up ramp up, maintenance rate, and ramp down to equal total volume desired over total time desired. NOTE: Remember to calculate GIR using your highest infusion rate to ensure you do not exceed maximum GIR (ex. 5 mg/kg/min)