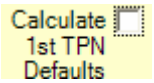
PARENTERAL NUTRITION
Central Line or Total (TPN) and Peripheral (PPN)

Before you start,

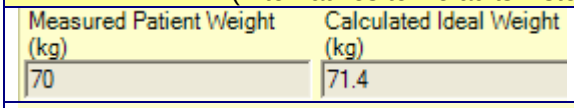
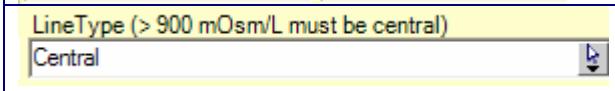
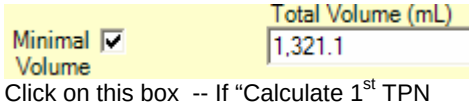
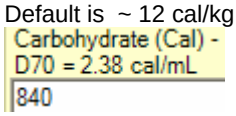
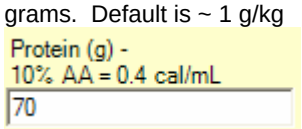
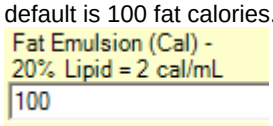
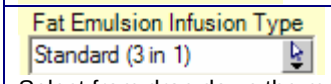
- **Obtain baseline labs**: Basic Metabolic Profile, Phos, Mg, Prealbumin, TGs , Chol, LFTs, CBC, INR
- **Know actual height & weight– determine IBW for TPN calculations (use actual weight if UNDER IBW);**
  - Make sure weights recorded in upper L hand box of TPN order form are appropriate; default values populated in form use "calculated ideal weight" (See Glossary of Terms). If calculating manually, use IBW in obese or grossly volume-overloaded patients.
- Know **fluid status** (I&Os; fistulas), and presence and extent of **renal and/or liver disease**
- For information on **normal nutritional requirements and goals:**
  - review sections starting on page 3
  - &/or try this helpful internet site: http://www.rxkinetics.com/tpntutorial/3_1.html

Writing Initial TPN Orders in Eclipsys Sunrise:

Start conservatively – easiest option is to use this check box on upper R of order form:



If this option yields values that do not appear appropriate or applicable on day 1, revise some or all of the defaults as noted in table below:

Field Name on Eclipsys Sunrise Form (with Explanations) Showing Values if "Calculate 1st TPN Defaults" Box is Checked (Alternatives to Defaults Listed in Parentheses)		**Sample of Alternative 1st Day Orders For a 70 kg "stable" male**
	**Calculations below are based on "Calculated Ideal Weight"**	**70kg**
	Select from drop down (If peripheral line, refer to PPN guidelines on page 4)	**Central Line**
 Click on this box -- If "Calculate 1st TPN Defaults" box is NOT checked	(Alternative: enter total volume desired per 24 hours; total volume can be changed to a higher volume by un-checking this box; but the volume cannot be made lower than this "minimal volume" value. See volume requirements on page 3)	**Minimal Volume**
Carbohydrate component furnished by 70% dextrose & ordered in calories. Default is ~ 12 cal/kg 	(Alternative: **1st – day carbohydrate requirement may be lower (500-800 calories);** Use lower end for a patient with: small stature, cachexia, a risk for refeeding syndrome, or if NPO for > 4 days)	**700 carbohydrate calories**
Protein component furnished by 10% amino acids (AA) solution and ordered in grams. Default is ~ 1 g/kg 	(Alternatives: requirements may be less in acute renal failure (RF) w/o intervention and in hepatic encephalopathy) **Note:** each gram of protein provides 4 Calories of energy	**70 g of protein**
Fat component is furnished by 20% fat emulsion and is ordered in calories. The default is 100 fat calories. 	(Alternative: 100 – 200 calories per day; usually no more than 30% of total non-protein calories should be fat calories)	**200 fat calories**
 Select from drop down the method of infusion: "Standard (3 in 1)" -- furnishes all 3 major nutrition sources in 1 bag OR "Piggyback over 24 hours"	**"Standard (3 in 1)" option is recommended unless notified of incompatibility issues.**	**Standard (3 in 1)**

Field Name on Eclipsys Sunrise Form (with Explanations) **Showing Values if "Calculate 1st TPN Defaults" Box is Checked** (Alternatives to Defaults Listed in Parentheses)		**Sample of Alternative 1st Day Orders For a 70 kg "stable" male**
Relevant Results (Click Icon) Sodium Serum: 144 Potassium Serum: 4.2 Chloride Serum: 105	Shows latest lab information; Review closely & make daily adjustments of any or all nutrients.	
Sodium (mEq) (usual 2 mEq/kg) 140 This cation may be furnished as chloride, phosphate or acetate anions (see Glossary)	(Alternative range between 1 – 2 mEq/kg) (2nd alternative is to calculate total volume and order amount equivalent to ½ NS or 77 mEq per Liter ordered)	**100 mEq Na**
Potassium (mEq) (usual 1 to 2 mEq/kg) 70 Default is 1 mEq/kg This cation may also be furnished as chloride, phosphate or acetate anions	(Alternative: 1 mEq per gram of protein)	**70 mEq K**
Balance Cations w/ (use Cl if Alkalotic) Acetate Default is to use acetate for the balance of the Na^+ and K^+ cations ordered and not furnished by the amounts of chloride or phosphate ordered below; Use drop down to switch to chloride	This grayed-out field gives calculated amount of the anion being used (acetate or chloride): Acetate (mEq) 59.73	**Balance with acetate**
Chloride (mEq) (usual = Sodium) 140	This anion furnished as Na^+ or K^+; Usually defaults to the number of sodium cations ordered	**100 mEq Cl**
Phosphorus (mmol) (usual 7 to 15 mmol/L) 11 Default is 0.15 mM/kg	This element furnished as Na^+ or K^+ phosphate; (Alternatives: 7 mM/1000 cal; less for renal failure; more as metabolic demand increases)	**10 mM**
Calcium (mEq) (usual 15 to 25 mEq Ca) 10	Furnished as calcium gluconate (Alternative range: 10 – 20 mEq)	**15 mEq**
Magnesium (mEq) (usual 10 to 30 mEq) 12	Furnished as magnesium sulfate (Alternative range: 12 – 20 mEq)	**16 mEq**

Other additives Displayed on Form

For micronutrient amounts in MVI & Trace Elements, see last page of guidelines

Multivitamins 10 mL
Thiamine 100 mg
Folate None
600 mcg furnished by MVI
Vitamin C (mg) 0
200 mg furnished by MVI
Vitamin K None
Default is none; may be ordered weekly or monthly from drop-down.
MVI has 150 mcg Vit K (this is the minimum recommended amount).
Fat emulsion has additional ~25 mcg Vit K per 100 mL of fat.

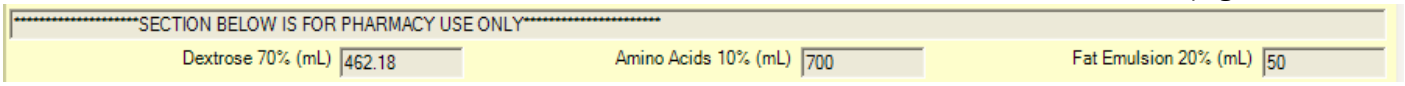
Trace Elements 2.5 mL
Zinc (mg)
Defaults to none; 2.5 mg provided by trace elements; add 5 mg if patient has catabolic stress; add 10 – 15 mg if patient has large GI losses
Selenium 40 mcg
Chromium None
Defaults to none; 10 mcg provided by trace elements; add 10 mcg if patient has large GI losses or is glucose intolerant

Regular Insulin (Units)
Avoid adding insulin to TPN if possible; use basal insulin detemir every 12 hours. Use of a regular insulin SS is no longer recommended. Continue to monitor glucoses every 6 hours and adjust basal insulin PRN.

Famotidine (mg)
Do not add if patient already on a PPI (pantoprazole of esomeprazole)

Determining the Volume of TPN orders

Macronutrients (Carbohydrates, Protein, and Fat) make up the majority of the volume; exact volumes for all additives may be viewed on the bottom of the order form. Here is the first line of default volumes for the default entries on page 1.



To manually calculate the volumes:

CHO: Standard solution is dextrose 70% ($D_{70}W$). This means 70 g per 100 mL or 0.7 g/1 mL
There are 3.4 cals per g of CHO;
Thus 1 mL = 0.7 gm = 2.38 cal e.g: 700 CHO cals / 2.38 ~ **294mL**

Protein: Standard solution is 10% amino acids (AA). This means 10 g per 100 ml or 1 g per 10 mL
e.g: 70g protein x 10 = **700mL**

Fat: Standard solution is a 20% fat emulsion which contains additional additives to yield 2 cals per mL
e.g: 200 fat calories = **100mL**

Additives: Volumes vary (exact volumes are given at bottom of form); usually **~ 200mL**

Estimated Total Volume from sample day 1 TPN =
294 mL $D_{70}W$
700 mL amino acids
100mL fat emulsion
200mL additives
~1294mL / day (this is the minimal volume)

If additional free water needed, "uncheck" the "Minimal" volume box and write total volume as needed – difference will be made up with sterile water; e.g. if 2000mL total needed, ~700mL sterile water will be added to above sample day 1 TPN.

Determining Goals

DAILY PROTEIN & CALORIE REQUIREMENTS	
Adapted from JPEN 2004 and http://www.rxkinetics.com/tpntutorial/3_1.html	
Note from link above: While protein provides 4 calories of energy per gram, it is needed for tissue synthesis & repair and is not routinely used to calculate basic energy requirements. The inclusion of protein in the calculation of energy requirements (called total calories vs. non-protein calories), is controversial. In a hypermetabolic (stressed) patient, protein may be used for energy – usually between 10 – 20 % of total.	
PROTEIN	
Maintenance	**0.8 – 1 g/kg**
Catabolic patients	**1.2 – 2 g/kg**
Chronic renal failure (renal replacement therapy)	**1.2 -- 1.5 g/kg**
Acute renal failure + catabolic	**1.5 – 1.8 g/kg**
ENERGY **Total calories :** **Non-protein-calories:** **70 – 85% as carbohydrate (CHO)** **15 – 30 % as fat**	**20 – 30 kcal/kg** **(usual max CHO utilization rate is 20 – 25 kcal/kg/day;)**
FLUIDS	**30 – 40 mL/kg**

Assess YOUR patient's requirements:

Sample patient:	70 kg Male; volume overloaded;	
Estimated TOTAL caloric requirement:	30 cal/kg	= 2100 cal/day
Estimated protein requirement:	1.5 g/kg	= 105 g Protein/day = 420 cal
Usual initial CHO cal utilization rate ~4 mg/kg/min, or ~20 cal/kg/day		= 1400 CHO cal
Need to use fats to make up difference to reach caloric goals:		
2100 TOTAL cal – (1400 CHO cal + 420 Protein cal)	= 280 fat cals per day (can round to 300 fat cal)	

TPN goals for this sample patient:	1400 CHO cals	Volume =	588mL
(NOT on the 1st day)	105g protein	+	1050mL
	300 fat cals	+	150 mL
		+	200 mL from other additives
	Total "minimal" volume	=	~1988 mL/day

For most patients, you can start on Day 1 with about half of the protein and non-protein-calorie goals. Increase daily, as tolerated, to goals, usually in 3 to 4 days. Adjust electrolytes and additives as indicated by current status, daily labs, fluid balance, etc.

If patient is malnourished, titration to max protein and caloric goals may take longer due to the risk for "**refeeding syndrome**" (see Glossary of Terms). In these patients, start with 1/3 of protein and caloric goals, and progress slowly. Too rapid a correction of protein & caloric depletion increases the risk. **To reduce the risk, correct electrolyte abnormalities before starting nutritional support and use daily electrolytes (K^+, Phos, Mg) to guide advancement; e.g. if low, do not increase macronutrients until electrolytes stable without requiring bolus replacements.**

Monitoring (enter standing orders):

Daily x first week:	Basic Metabolic Profile, Mg, Phos, CBC
(When stable, decrease to once or twice a week.)	
Daily:	Weight, Accuchecks as indicated, Accurate I&Os, Vitals
Weekly:	TGs, LFTs, PREalbumin, CRP-standard
(unless otherwise indicated)	

Once PN infusing, (Pertains to both TPN and PPN):

1. Orders must be submitted before 3pm DAILY
2. Bags infuse over 24 hrs, eg: from ~ 4pm to 4pm
3. Bags are discarded at the 24-hr mark, to decrease risk of contamination.

PPN (Peripheral Parenteral Nutrition)

Requires significant volume, to maintain "safe" osmotic load to peripheral vein (< 900mOsm/L)
∴ ***NOT*** indicated for patients requiring *fluid restriction.*

Rules of Thumb:	Days 1 & 2	Day 3, if stable	If est'd Nutrition needs not yet met, and large volume tolerated: Day 4	Day 5
Total Vol (mL)	2200	2600	3100	3300
CHO cals	500	650	800	1000
Fat cals	500	650	800	1000
g Protein	70	75	85	100
mEq Na, Cl (avg ~1/2NS)	165	200	250	290

- Electrolytes follow same basic principles as central TPN, except for Na and Cl as indicated
- Monitor for infiltration; do NOT use TPN orders in peripheral vein; though PPN can be infused via a central line
- Change line or switch to central line for TPN within 7-10 days, depending on venous integrity
- Monitor labs, weights, etc., as with TPN
- Line should be changed every 3 or 4 days or more often if irritation develops
- Addition of heparin is no longer recommended; the addition of fats and keeping the osmolarity below 900 mOsm/L should minimize peripheral vein irritation

GLOSSARY OF TERMS	
Acetate	An anion that is a precursor or "supplier" of bicarbonate (Sodium bicarbonate is incompatible in TPN solutions); used when acidosis is present or a risk
Anion	A negatively-charged ion; Anions pertinent when ordering electrolytes for TPN solutions are **chloride, phosphate, and acetate**; The number of anions and cations ordered in a TPN must "balance" because they can only be supplied as a combination of the following salts: sodium chloride &/or potassium chloride; sodium phosphate &/or potassium phosphate; sodium acetate &/or potassium acetate
Basic Metabolic Profile	New term for the old "Chem 7" lab order which includes: Serum Sodium, Potassium, Chloride & Calcium; Total Serum Carbon Dioxide; Anion Gap; Serum Glucose; Blood Urea Nitrogen; Serum Creatinine
Cal	The common abbreviation for kilocalories (the standard unit of energy used in clinical nutrition); Carbohydrates and protein provide 4 calories per gram; Fat provides 9 calories per gram (our fat emulsion has additives that boost that number to 10 cal/gm)
Calculated Ideal Weight	Based on a body-mass index formula that is useful for all heights including the very short or very tall. The usual methods of calculating the Ideal Body Weight (Devine or Robinson) cannot be used if height is less than 5 feet.
Cation	A positively-charged ion; Cations pertinent when ordering electrolytes for TPN solutions are **sodium and potassium**; The number of cations and anions ordered in a TPN must "balance" (see "anion" above)
CBC	The "Complete Blood Count" lab order which includes: White Blood Cell Count & Red Blood Cell Count; Hemoglobin & Hematocrit MCV, MCH, MCHC, RDW; Nucleated RBC & Absolute Nucleated RBC Platelet Count and an Automated Interpretation.
Chem 7	Old term for the **Basic Metabolic Profile** (see above)
CHO	Carbohydrate
Chol	Serum Cholesterol
CRP	There are two lab tests for CRP or **C-reactive Protein :** • The standard test assesses the "general degree of inflammation" **(choose this one)** • The "high Sensitivity" test assesses "CARDIAC risk"
IBW	Ideal Body Weight; see "Calculated Ideal Weight" above
INR	International Normalized Ratio; the ratio of a patient's prothrombin time to a normal (control).
JPEN	The *Journal of Parenteral and Enteral Nutrition*
LFTs	**Liver Profile lab order which includes:** Serum Albumin, Total Serum Protein; Direct &Total Bilirubin; Serum AST/SGOT, and ALT/SGPT; and Serum Alkaline Phosphatase
Mg	Serum Magnesium
Phos	Serum Phosphorus
PPI	Proton Pump Inhibitor; if patient is on one, there is no need to add an H_2-blocker like famotidine.
Refeeding Syndrome	A syndrome caused by initiating feeding too rapidly in severely malnourished patients. The sudden increase in metabolic demand causes a decrease in circulating levels of potassium, magnesium and phosphorus. The sequelae may affect every organ system and may lead to cardiac arrhythmias, heart failure, acute respiratory complications, paralysis, nephropathy, and liver dysfunction. (Definition adapted from http://www.rxkinetics.com/tpntutorial/3_3.html). This reference also helps identify patients at risk)
TG	Serum Triglyceride

Information on Micro-nutrients

Micro-nutrient	Recommended Daily Adult Requirements *JPEN* 2004	Furnished by Pharmacy Preparation Listed		Total "1st-Day Default" Amounts
		MVI Adult (Hospira) As of Dec 2008 Amounts per 10 mL	**Various individual Supplements**	
			Default Additional Amounts	
			Thiamine Inj 100 mg/mL	
Thiamine (B_1)	6 mg	6 mg	**100 mg**	106 mg
Riboflavin (B_2)	3.6 mg	3.6 mg		3.6 mg
Niacin (B_3)	40 mg	40 mg		40 mg
			Folic Acid Inj 5 mg/mL	
Folic acid	0.6 mg	0.6 mg	**No additional**	0.6 mg
Pantothenic acid	15 mg	15 mg		15 mg
Pyridoxine (B6)	6 mg	6 mg		6 mg
Cyanocobalamin (B12)	5 mcg	5 mcg		5 mcg
Biotin	60 mcg	60 mcg		60 mcg
			Ascorbic acid 500 mg/mL	
Ascorbic acid (C)	200 mg	200 mg	**No additional**	200 mg
Vitamin A	3300 IU	3300 IU		3300 IU
Vitamin D	200 IU	200 IU		200 IU
Vitamin E	10 IU	10 IU		10 IU
			Fat emulsion 20%	
Vitamin K	150 mcg	150 mcg	**~25 mcg / 100 mL**	~ 175 mcg
			Phytonadione Inj 10 mg/mL	
			No additional	
		Trace Elements (American Regent) as of Dec 2008 Default Amounts per 2.5 mL	**Various individual Supplements**	**Total "Default" Amounts**
			Chromium 4 mcg/mL	
Chromium	10- 15 mcg	10 mcg / 2.5 mL	**No additional**	10 mcg
Copper	0.3 – 0.5 mg Less in Hepatobiliary Disease	1 mg / 2.5 mL		1 mg
Manganese	60 – 100 mcg Less in Hepatobiliary Disease	250 mcg / 2.5 mL		250 mcg
			Zinc Sulfate 1 mg/mL	
Zinc	2.5 – 5 mg	2.5 mg / 2.5 mL	**No additional**	2.5 mg
			Selenium Inj 40 mcg/mL	
Selenium	20 – 60 mcg		**40 mcg**	40 mcg
Note: long-term TPN use requires serum monitoring of trace elements including aluminum to avoid toxicity				