Adult Parenteral Nutrition Management

Pharmacy Grand Rounds – Virtual Event

Tina Dinh, Pharm D
Inpatient Clinical Pharmacist IV, Sutter Medical Center Sacramento

Gagandeep Kaur, Pharm D
Inpatient Clinical Pharmacist IV, Memorial Medical Center Modesto

Omi Patel, Pharm D
Inpatient Pharmacy Supervisor, Sutter Santa Rosa Regional Hospital

January 2026

Sutter Health

Learning Objectives

Upon completion of this learning activity, participants should be able to:

1. Assess a patient's condition to determine indications for parenteral nutrition and when to start therapy.
2. Correctly identify parenteral nutrition composition, including macronutrients, electrolytes, vitamins, trace elements, and other additives.
3. Demonstrate fluid and glycemic management, enteric feeding, cyclic considerations, special population management, and TPN shortage management.
4. Appropriately apply SH pharmacy protocol, including EPIC order entry and verification, to direct patient care.

Baseline Knowledge Statements

CE instructions

Agenda

1. Who needs parenteral nutrition? – Tina Dinh
2. Macronutrients – Tina Dinh
3. Initiating Parenteral Nutrition – Gagandeep Kaur
4. Electrolyte Review – Gagandeep Kaur
5. Glycemic Control – Omi Patel
6. Transitioning to and from enteral feeding
7. Cyclic Consideration

Who needs parenteral nutrition?

(or conversely who doesn’t or no longer needs nutrition)

Parenteral Nutrition Indication

Unable to tolerate EN ≥ 5 days

- Severe hemodynamic instability (rate of malnutrition accelerated in critical illness)
- Prolonged ileus
- Intractable vomiting/diarrhea
- Upper GI bleed

- Bowel Obstruction
- Short bowel syndrome
- Malabsorption
- Major GI ischemia
- GI fistula

Cancer dx and unable to tolerate EN ≥ 7 days

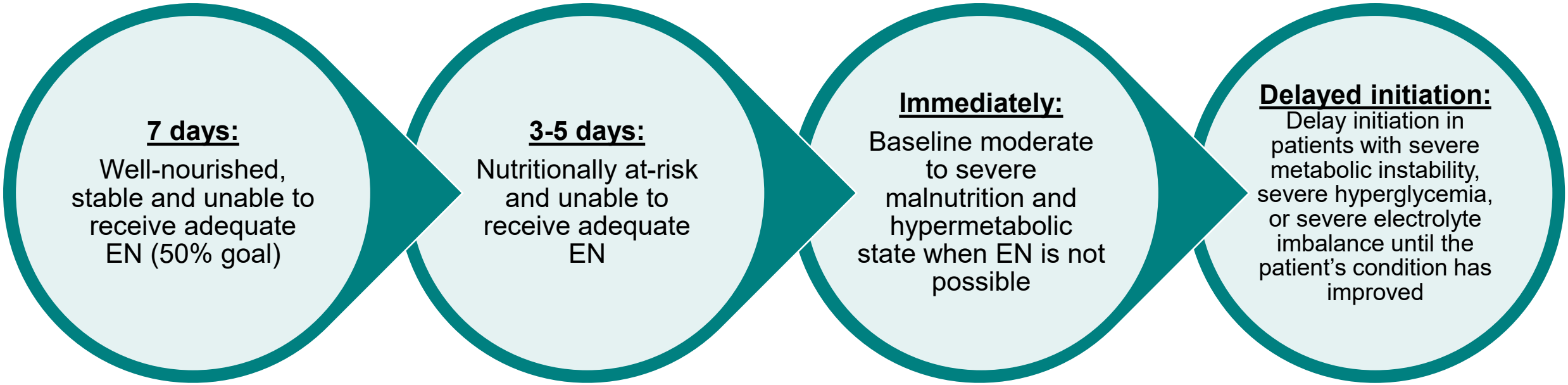
- Stem cell transplant
- Undergoing chemotherapy and experiencing significant GI toxicity

Severe Pancreatitis

- EN Preferred
- PN reserved only for patients who have tried and failed enteral nutrition

Pharmacists to review indication daily and recommend tapering and discontinuation if PN is no longer indicated

Initiation of Parenteral Nutrition



Malnutrition vs Nutritionally-At-Risk

Malnutrition

- Acute, subacute, or chronic state of over/under-nutrition which led to change in body composition and diminished function
- *Starvation-related malnutrition*: Anorexia nervosa
- *Chronic disease-related malnutrition*: Organ failure, cancer
- *Acute disease or injury-related malnutrition*: Major infection burns, trauma, TBI

Nutritionally-At-Risk

- Involuntary weight loss of 10% of usual body weight within 6 months or 5% within 1 month
- Involuntary loss of 10 lb within 6 months
- Body mass index (BMI) less than 18.5 kg/m^2
- Increased metabolic requirements
- Altered diets or diet schedules
- Inadequate nutrition intake, including not receiving food or nutrition products for more than 7 days

Examples of Inappropriate PN Indication

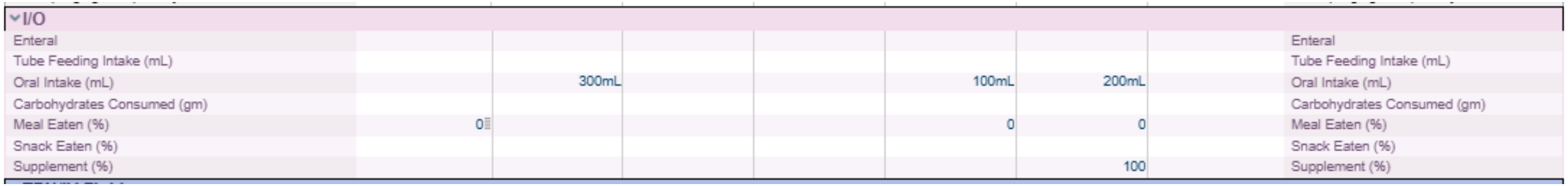
- 65 yo male POD1–3 after abdominal surgery with temporary ileus
- 58 yo male with septic shock, improving on low-dose norepinephrine has been NPO for 3 days. A CT abdomen shows mild bowel wall edema but no obstruction or ischemia. He is tolerating trophic enteral feeds at 10 mL/hr with no residuals. The surgical team requests TPN “to prevent catabolism.”
- 44 yo female undergoing chemoradiation develops mucositis so severe she cannot eat orally. However, small-bowel function is normal and a nasojejunal tube was placed successfully with tolerance of 20–30 mL/hr elemental feeding. Oncology proposes TPN due to “poor oral intake.”

Examples of Inappropriate PN Indication

Enteral nutrition meets 60% of calorie needs

Meals can be viewed under “Diabetes Management” Accordion

Active Diet orders and Supplementation



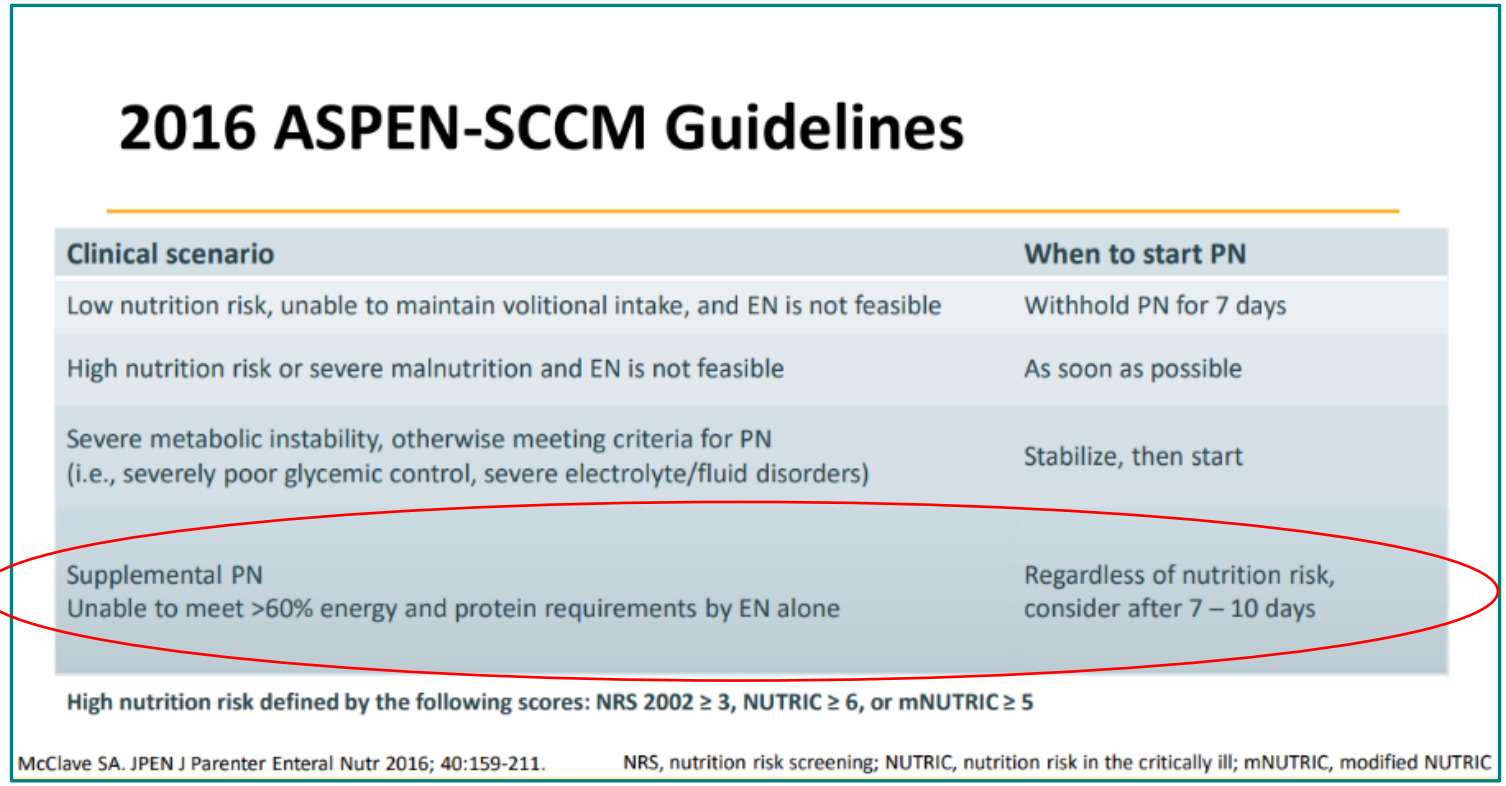
I/O							
Enteral							Enteral
Tube Feeding Intake (mL)							Tube Feeding Intake (mL)
Oral Intake (mL)		300mL			100mL	200mL	Oral Intake (mL)
Carbohydrates Consumed (gm)							Carbohydrates Consumed (gm)
Meal Eaten (%)	0				0	0	Meal Eaten (%)
Snack Eaten (%)							Snack Eaten (%)
Supplement (%)						100	Supplement (%)

Multidisciplinary team approach. Consult RD as needed

MD order required to taper and/or discontinue PN

What about supplemental PN?

Unable to meet >60% energy and protein requirements by EN alone



2016 ASPEN-SCCM Guidelines

Clinical scenario	When to start PN
Low nutrition risk, unable to maintain volitional intake, and EN is not feasible	Withhold PN for 7 days
High nutrition risk or severe malnutrition and EN is not feasible	As soon as possible
Severe metabolic instability, otherwise meeting criteria for PN (i.e., severely poor glycemic control, severe electrolyte/fluid disorders)	Stabilize, then start
Supplemental PN Unable to meet >60% energy and protein requirements by EN alone	Regardless of nutrition risk, consider after 7 – 10 days

High nutrition risk defined by the following scores: NRS 2002 ≥ 3, NUTRIC ≥ 6, or mNUTRIC ≥ 5

McClave SA. JPEN J Parenter Enteral Nutr 2016; 40:159-211.

NRS, nutrition risk screening; NUTRIC, nutrition risk in the critically ill; mNUTRIC, modified NUTRIC

Chart adopted from ACCP Annual Meeting 2025
American Society for Parenteral and Enteral Nutrition (ASPEN). Appropriate dosing for parenteral nutrition: ASPEN recommendations. November 2020. Available at: https://www.nutritioncare.org/ProductShortageManagement/. Accessed November 25, 2025.https://www.dietaryguidelines.gov/sites/default/files/2021-03/Dietary_Guidelines_for_Americans-2020-2025.pdf

2022 ASPEN Guidelines (Evidence/Strength)

Higher vs. lower energy provision	No significant difference in clinical outcomes was found between patients with higher vs lower levels of energy intake. No change (Moderate/Weak)
Higher vs. lower protein intake	No difference in clinical outcomes in the relatively limited data. No change. (Low/Weak)
Exclusive EN vs. PN during the first week of critical illness	No significant difference in clinical outcomes. Because similar energy intake provided as PN is not superior to EN and no differences in harm were identified, we recommend that either PN or EN is acceptable. In practice. (ESPEN 2023 **EN is preferred over PN if feasible**) (High/Strong)
Supplemental PN when EN isn't sufficient or feasible	No significant difference in clinical outcomes. Recommend not initiating SPN prior to day 7 of ICU admission (High/Strong)
Lipid injectable emulsion (ILE) product selection	Suggest that either mixed-oil ILE or 100% soybean-oil ILE be provided to critically ill patients (Low/Weak)

Compher C, Bingham AL, McCall M, et al. Guidelines for the provision of nutrition support therapy in the adult critically ill patient: The American Society for Parenteral and Enteral Nutrition. *J Parenter Enteral Nutr*. 2022;46(1):12-41. doi:10.1002/jpen.2267

Considerations for SPN

In patients without malnutrition or nutrition risk:

- ICU day 7 or later (late SPN) if unable to receive adequate EN (50 - 80% goal)

In patients with malnutrition or nutrition risk:

- Early SPN (before day 7) if unable to receive adequate EN

Examples

Frequent interruptions to EN (procedures, surgery)

Unable to advance EN rate due to clinical status or EN intolerance

High output/malabsorption (fistula, ostomy, diarrhea)

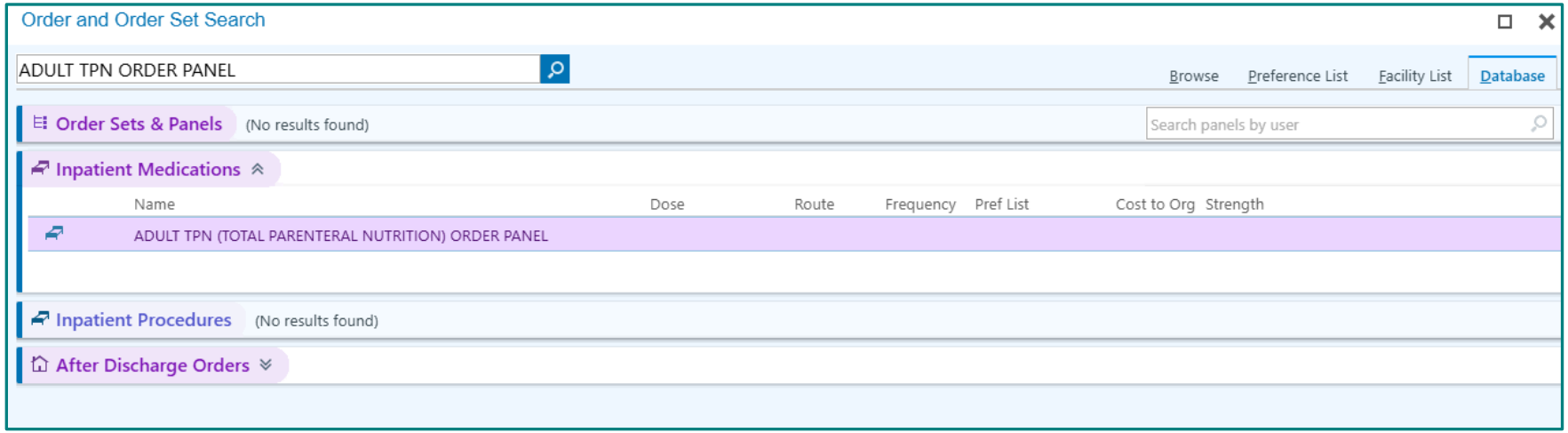
Compher C, Bingham AL, McCall M, et al. Guidelines for the provision of nutrition support therapy in the adult critically ill patient: The American Society for Parenteral and Enteral Nutrition. *J Parenter Enteral Nutr*. 2022;46(1):12-41. doi:10.1002/jpen.2267
Ridley EJ. Parenteral nutrition in critical illness: total, supplemental or never? *Curr Opin Clin Nutr Metab Care*. 2021;24(2):176-182. doi:10.1097/MCO.0000000000000719
Singer P, Blaser AR, Berger MM, et al. ESPEN practical and partially revised guideline: Clinical nutrition in the intensive care unit. *Clin Nutr*. 2023;42(9):1671-1689. doi:10.1016/j.clnu.2023.07.011

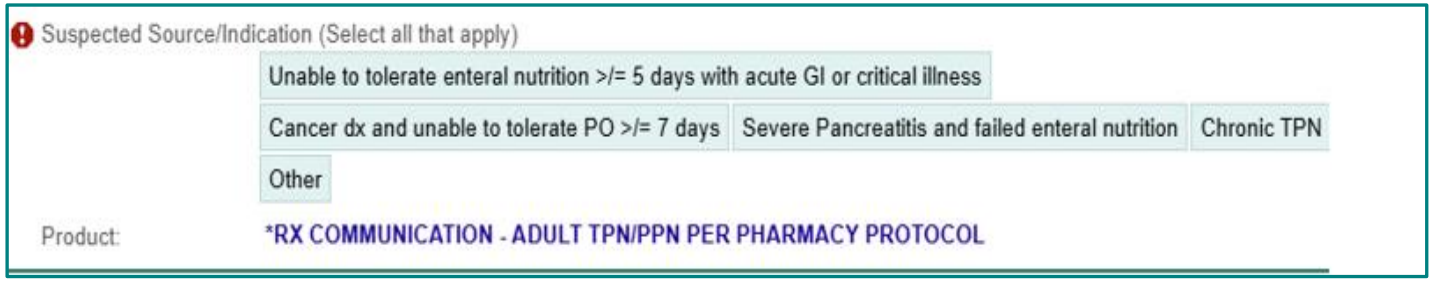
Sutter Order Panel

Adult TPN (Total Parenteral Nutrition) Order Panel

***Rx Communication – Adult TPN/PPN per Pharmacy Protocol Order**

- Provider will select TPN, PPN, or cyclic TPN per pharmacy protocol order
- Provider will select an indication for parenteral nutrition

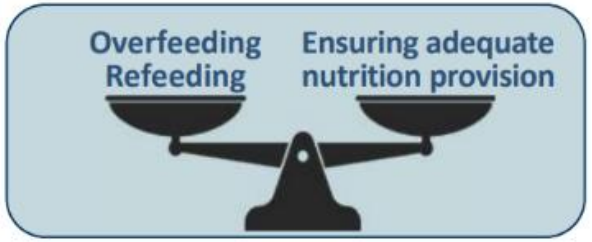




Key Considerations for Initiation and Titration of PN

- Avoid overfeeding in all patients
- Advance slowly and cautiously in patients with severe malnutrition
- Use conservative energy goals during early phases of critical illness (ICU day 1-2) or when acute worsening of clinical status occurs
- Full energy goals should be targeted on later days of acute critical illness phase (ICU day 3-7)

Collaborate with RD to determine energy and macronutrient goals



Patient Case: Meet SL

76 yo male (65kg, 68 in) in the MICU sp ex-lap for bowel perforation. While waiting for bowel recovery, the team consulted pharmacy to start parenteral nutrition. Prior to admission, pt reported limited oral intake for about 2 weeks due to abdominal discomfort. All ILE forms are available for PN use. Pt has a PICC line. D5W+LR running at 75 ml/hr. I/O: ~300ml from IV medications. Medical team asks pharmacy to help start PN for this pt.

	Day 1
Na	134
K	3.6
Cl	104
CO2	16
BUN	15
Cr	0.8
Glu	92

	Day1
WBC	5.5
Hgb	8.2
Hct	23.6
PLT	140

Patient Case: Meet SL

- What is SL’s goal energy and fluid requirement?
- What type of IV access does SL have?
- What weight (kg) would you use?
- How would you dose SL’s AA, Dextrose and Lipids?
- What additional labs would you order?
- Any other considerations?

General Macronutrients Decision Making

Determine patient weight (kg): ideal vs actual vs adjusted

Calculate total energy requirements: total kcal (based on kcal/kg)

Total kcal = AA kcal + Lipid kcal + Dextrose kcal

Calculate total fluids or per MD (ml)

Calculate amino acids: g/kg or AA = 4 kcal/grams

Calculate lipid frequency: daily vs every other day vs TIW

Calculate carbohydrate: 3.4 kcal/grams. Watch for GIR

Total kcal – AA kcal – Lipids kcal = Dextrose kcal

Energy Requirements

Patient Condition		Energy Requirements (kcal/kg/day)	Dosing Weight (kg)
Stable (BMI < 30)	-	20 - 30	Actual body weight
Obese (BMI ≥ 30)	-	22 – 25	Ideal body weight
Critically ill, metabolic stress, trauma, undernourished	-	12 – 25	Actual body weight
Critically ill obese (BMI ≥ 30)	BMI 30-50	11-14	Actual body weight
	BMI > 50	22-25	Ideal body weight
Chronic Kidney Disease (CKD)	-	30-35	Actual body weight
Acute Kidney Injury (AKI)	-	20-30	Actual body weight
Pregnancy	2nd trimester	Add 340 calories to pre-pregnancy needs	Pre-pregnancy weight
	3rd trimester	Add 450 calories to pre-pregnancy needs	
	Lactation (1st 6 months)	Add 330 calories to pre-pregnancy needs	
	Lactation (2nd 6 months)	Add 400 calories to pre-pregnancy needs	

American Society for Parenteral and Enteral Nutrition (ASPEN). Appropriate dosing for parenteral nutrition: ASPEN recommendations. November 2020. Available at: https://www.nutritioncare.org/ProductShortageManagement/. Accessed November 25, 2025.https://www.dietaryguidelines.gov/sites/default/files/2021-03/Dietary_Guidelines_for_Americans-2020-2025.pdf

Ideal Body Weight (IBW):
Males: 50 kg + 2.3 kg per inch over 5 ft
Females: 45.5 kg + 2.3 kg per inch over 5 ft

Fluid Requirements

- Daily fluid requirement consideration:
  - 30 - 40 mL/kg/day
- Fluid reduction indications:
  - Heart failure, renal failure, excess IV fluids from other sources (IV meds, IV fluids, flushes)
- Fluid losses requiring additional fluids:
  - Ostomies, nasogastric tube, enterocutaneous fistulas, chyle leaks

Ayers P, Bobo ES, Hurt RT, Mays AA, Worthington PH, eds. *ASPEN Parenteral Nutrition Handbook*. 3rd ed. Silver Spring, MD: American Society for Parenteral and Enteral Nutrition; 2020. ISBN: 978-1-889622-41-5.

Intravenous Access

Verify IV access and determine appropriateness of type of PN ordered by provider

	Total Parenteral Nutrition (TPN)	Peripheral Parenteral Nutrition (PPN)
IV Access	Central	Peripheral
Catheter types	PICC, implanted port, internal jugular/subclavian/femoral central line.	Peripheral IV lines and midline catheters.
Max osmolarity	Unlimited	900 mOsm/L*
Recommended Use	Preferred for patients requiring PN for > 7 days	Used for temporary, short-term nutrition support (≤ 7 days)
Considerations	• Less restrictive as delivery to a larger vein allows for greater dextrose tolerance • Central lines can be maintained for a longer duration and are therefore preferred for long term PN delivery • Can be concentrated for patients requiring fluid restriction	• Requires greater fluid volume to maintain osmolarity, and reduced electrolyte content to prevent phlebitis. Avoid in the following scenarios: ○ Significant malnutrition (>5% weight loss in past 3 months) ○ Severe metabolic stress ○ Large nutrient or electrolyte needs (potassium is a strong vascular irritant) ○ Fluid restriction ○ Need for prolonged PN (>2 wk) ○ Renal or hepatic compromise

* For osmolarity between 900 - 1000, individual patient assessment must be performed for clinical need and patient safety

Macronutrients

Carbohydrates, Protein, & Lipids

Registered Dietician (PD) will document recommendations as a nutrition assessment note in EPIC

Protein Requirements

- Calorie contribution: 4 kcal/g
- Initial protein can start at goal in Day 1 PN
- Dosing weight
  - Use actual body weight (dry weight) for BMI < 30 kg/m^2
  - Use ideal body weight (IBW) for BMI ≥ 30 kg/m^2

Protein Requirements

Patient Population	Protein Requirement (g/kg/day)	Patient Population	Protein Requirement (g/kg/day)
Stable	0.8 – 1.5	**Traumatic brain injury**	1.5 – 2.5
Pregnancy	1.2 (1st trimester) 1.52 (2nd and 3rd trimester)	**Burns**	1.5 – 2.5
Renal failure non-critically ill	0.6 – 0.8 (CKD) 1.2 (CKD on dialysis) 0.8 – 1 (AKI)	**Critically ill, trauma, sepsis, undernourished**	1.2 – 2
Renal failure critically ill	Initial 1 (AKI or CKD) 1.3 – 1.5 (AKI or CKD on dialysis) 1.5 – 1.7 (AKI or CKD on RRT)	**Open abdomen**	Additional 15-30 g/L of exudate lost
Hepatic failure	1.2 (non-malnourished patients) 1.5 (malnourished)	**Obese**	2 (BMI 30-40; use IBW) 2.5 (BMI > 40; use IBW)

American Society for Parenteral and Enteral Nutrition (ASPEN). Appropriate dosing for parenteral nutrition: ASPEN recommendations. November 2020. Available at: https://www.nutritioncare.org/ProductShortageManagement/. Accessed November 25, 2025

Lipids

- Intralipid 20% or SMOFlipid 20% to be dispensed from pharmacy
- Daily requirements: (round to nearest whole bag size)

  Max: 2.5 g/kg/day or <60% of total daily energy requirements

  Stable

    - Intralipid 20% 250ml 1 gram/kg/day and at least 15-30% of total kcal.
    - Minimum: 2x weekly will meet EFA requirements. Provide more frequently to meet caloric requirement

  Critically ill

    - Intralipid 20% 250ml <1 g/kg/day and at least 15-30% of total kcal
    - Switch to mixed lipid formulation (e.g. SMOFlipid) ONLY if planning to continue PN long term (> 3 weeks) with elevated TG above 200 or in cholestasis (direct bilirubin >/= 1.5 mg/dL)
      - Dose: 1 – 2 g/kg/day. Begin at intralipid 20% dose and advance to goal SMOFlipid as tolerated
- 20% = 2 kcal/ml; 250 ml = 50 grams = 500 kcal

Lipid Considerations

- Calorie contribution: 10 kcal/g (Intralipids 20% = 2 kcal/mL)
- Daily requirements:
  - Stable: Intralipid 20% 250 mL 2x weekly will meet essential fatty acid (EFA) requirement. Provide more frequently to meet caloric need
  - Critically ill: Switch to SMOFlipid ONLY if planning to continue PN long term (>3 weeks) or in cholestasis (direct bilirubin ≥ 2mg/dL)
- Max dose: 2.5 g/kg/day or < 60% of total daily energy requirements
- Max infusion rate: 0.11 g/kg/hr
- Infusion time: 12 hours

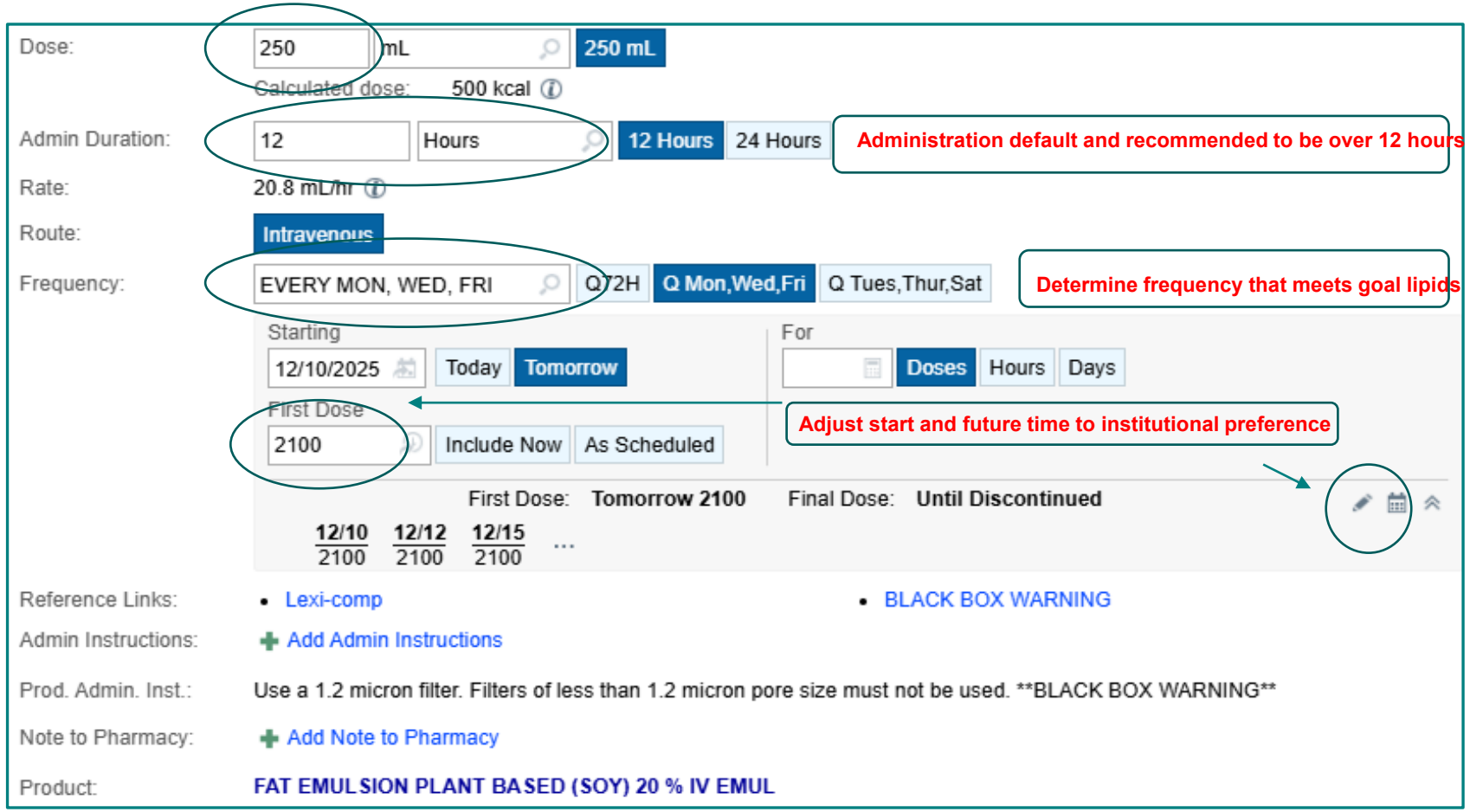
Ayers P, Bobo ES, Hurt RT, Mays AA, Worthington PH, eds. *ASPEN Parenteral Nutrition Handbook*. 3rd ed. Silver Spring, MD: American Society for Parenteral and Enteral Nutrition; 2020. ISBN: 978-1-889622-41-5.
2019 ASPEN Recommendations on Appropriate Parenteral Nutrition Dosing for Adult Patients

Lipid Considerations

Triglycerides (TG)> 200	**- Monitor TG more frequently - Reduce lipid dose to minimum amount (e.g. Intralipid 20% 250mL 2x weekly to prevent EFAD) - Consider switching to SMOFlipid**
Triglycerides (TG)> 400	- HOLD lipids - Monitor TG frequently (consider every 1-2 days until levels stabilize below 200 mg/dL)
Patients on Propofol/Clevidipine	- Propofol provides 1.1 kcal/mL - Clevidipine provides 2 kcal/mL - Calculate total kcal provided and adjust lipid emulsion accordingly

Ayers P, Bobo ES, Hurt RT, Mays AA, Worthington PH, eds. *ASPEN Parenteral Nutrition Handbook*. 3rd ed. Silver Spring, MD: American Society for Parenteral and Enteral Nutrition; 2020. ISBN: 978-1-889622-41-5.

Lipids



20% = 2 kcal/ml; 250 ml = 50 grams = 500 kcal

Reminder to round to whole bag size

Carbohydrate (Dextrose) Considerations

- Calorie contribution: 3.4 kcal/g
- Max osmolarity:
  - Peripheral line: 900 mOsm/L
  - Central line: Unlimited
- Max Glucose Infusion Rate (GIR):
  - Stable: ≤ 5 mg/kg/min (to reduce the risk of lipogenesis, fatty liver, cholestasis, and hypercapnia)
  - Critically ill, trauma, sepsis : < 4 mg/kg/min

$$Glucose\ infusion\ rate\ (mg/kg/min) = \frac{(dextrose\ in\ g/kg/day) \times \left(\frac{1000\ mg}{1\ g}\right)}{\left(\frac{24\ hr}{1\ day}\right) \times \left(\frac{60\ min}{1\ hr}\right)}$$

Patient Case: Meet SL

76 yo male (65kg, 68 in) in the MICU sp ex-lap for bowel perforation. While waiting for bowel recovery, the team consulted pharmacy to start parenteral nutrition. Prior to admission, pt reported limited oral intake for about 2 weeks due to abdominal discomfort. All ILE forms are available for PN use. Pt has PICC line. D5W+LR running at 75 ml/hr. I/O: ~300ml from IV medications. Medical team asks pharmacy to help start PN for this pt.

	Day 1
Na	134
K	3.6
Cl	104
CO2	16
BUN	15
Cr	0.8
Glu	92

	Day1
WBC	5.5
Hgb	8.2
Hct	23.6
PLT	140

Questions we want to ask:

- What additional labs would you order before formulating PN?
- What is SL's goal energy and fluid requirement?
- What type of IV access does SL have?
- What weight (kg) would you use?
- How would you dose SL's AA, Dextrose and Lipids?
- Any other considerations?

Patient Case: Meet SL

What is SL's goal energy and fluid requirement?

Energy: 12-25 kcal/kg/day → 20 kcal/kg/day (In the ICU, sp ex-lap. Considered critically ill) = 1300 kcal

Fluid: 30-40 ml/kg/day → 35 ml/kg/day = 2275 ml/day.

- I/O: Taking into consideration his other IV medications (~300ml). PN volume 2000 ml

What type of IV access does SL have?

PICC. Osmolarity not a concern

What weight (kg) would you use?

BMI: 21, use actual body weight 65 kg

How would you dose SL's AA, Dextrose and Lipids?

Total kcal – AA kcal – Lipids kcal = Dextrose kcal

AA = 1.2-2 g/kcal/day→ 1.5 g/kcal/day = 97.5 g x 4 kcal/gram = 390 kcal

Lipids = 1 g/kg/day = 65 g. Round nearest whole bag size 50 g (250 ml) = 500 kcal (<30% of total kcal)

Dextrose = 1300 kcal – 390 kcal (AA) – 500 kcal (IL) = 410 kcal div 3.4 kcal/g = 120 grams of dextrose

Remember that D5W+LR at 75 ml/hr? → Stop IV maintenance fluids when start PN

Examples where PN could have been optimized

Recommended needs:

Estimated Nutrition Needs: (based on IBW 68.2 kg, severe pancreatitis, PCM):
2050-2400 Kcal/day (~30 kcal/kg)
80-135 gm protein/day (1.2-2 gm pro/kg)
>1.7 L fluid/day (25 mL/kg) or per MD
TPN order: 450 gm dextrose, 95 g AA, 250 mL 20% SMOF 3x/week
Provides 2124 kcal, GIR = 4.03 mg/kg/min (using 77.6 kg wt)

Multidisciplinary approach to provide tailored formula per patient condition!!

What ended up happening:

Pt needing 45 units of insulin to help manage blood sugar
Pt switched to SMOF due to rise in LFT (which can be an early sign of hepatic steatosis). GIR 4

Optimizing macronutrient distribution:

Total kcal 2050-2400 kcal/day

AA 80 - 135 g (320-540 kcal) AA

Lipids 1g/kg/day = 70 g (700 kcal, still remains <30% recommendation which can be rounded to 250ml 50g daily),

Remain kcal are dextrose = 860 kcal (252 g) Dextrose.

HALF THE AMOUNT OF DEXTROSE REQURED!!

Examples where PN could have been optimized

Multidisciplinary approach to provide better patient care!!

<u>Recommended needs</u>:

Estimated Nutrition Needs: (based on 60.9 kg, post-op healing):

1800-1850 Kcal/day (30 kcal/kg)

75-90 gm protein/day (1.2-1.5 gm pro/kg)

1.5 L fluid/day (25 mL/kg) or per MD

TPN Order: 75 g AA, 390 g dextrose + 250 mL 20% Intralipids 3x/week

Additives: 1 mL trace elements, 10 mL multivitamins, 40 units insulin

Provides: 1840 kcal/day, 75 g protein/day, GIR of 4.45 mg/kg/min (using 60.9 kg admit weight)

<u>What ended up happening :</u>

Pt needed 40 units of insulin to help manage blood sugar. GIR 4.5

ASPEN recommendation:

Total kcal 1800-1850 kcal/day, AA 75-90 g (300-360 kcal) AA, Lipids ~1g/kg/day, less than 30% of total kcal = 250ml (=50 g (500 kcal) daily , remain kcal are dextrose = 290 g (990 kcal) Dextrose.

Initiating and Titrating Parenteral Nutrition

Patient Case

CC:

Abdominal pain

HPI:

MR is 75 yo male, presents with 4 days of abdominal pain, persistent vomiting, abdominal distention, and inability to tolerate/minimal oral intake last 10 days. CT abdomen shows **high-grade small bowel obstruction (SBO)** with transition point in the mid-jejunum. No signs of immediate bowel ischemia. **Nasogastric tube placed -> high-volume** bilious output. Patient kept NPO, due to prolonged NPO and poor nutritional history, provider orders PPN

PMH:

Hypertension, Hyperlipidemia, GERD

Allergies:

No known allergies

Patient Case Continued

	Day 1
Lab	Value
Na	136 mEq/L
K	3.2 mEq/L
Cl	95 mEq/L
HCO_3	28 mEq/L
Mg	1.8 mg/dL
PO4	2.1 mg/dL
Ca	8.4 mg/dL
Albumin	2.7 mg/dL
SCr	1.1 mg/dl
Glucose	111 mg/dL

Vitals:

- BP: 127/58
- Pulse: 87
- Temp: 99.7 °F
- Resp: 18
- SpO_2: 98%
- Height: 172.7 cm (68")
- Weight: 92.5 kg
- BMI: 31.02 kg/m²

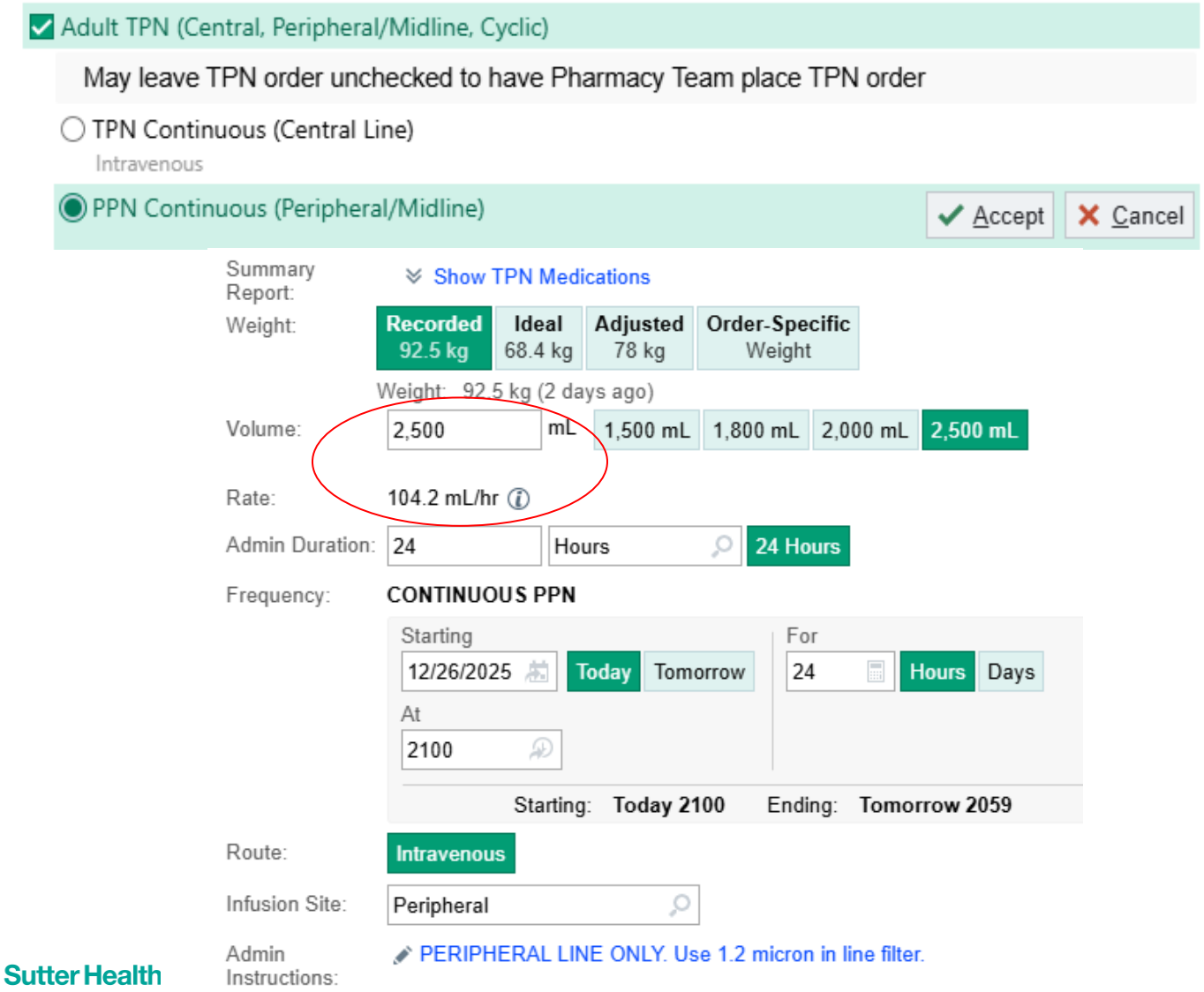
Current Relevant Medication:

- **0.9% NaCl at 75 ml/hr**
- Electrolyte repleted:
  - **Potassium chloride 10 mEq IV x 4 doses**
  - **Sodium phosphate IV 15 mmol x 1**
  - **Magnesium sulfate IV 2 gm x1**

Under “Intake/Output” can assess patient I&O

		Dec 5 - Dec 6			
		0700 - 1459	1500 - 2259	2300 - 0659	Daily Total
In	P.O.	0	0	0	0
	Intake: P.O.	0	0	0	0
	I.V.			1,339.2	1,339.2
	NG/GT	90	90		180
	Total Intake	**90**	**90**	**1,339.2**	**1,519.2**
Out	Urine		1,550	1,000	2,550
	Emesis/NG Output		300	400	700
	Stool	0			0
	Total Output	**0**	**1,850**	**1,400**	**3,250**

Initiate PPN



- **Daily Fluid Requirement 30-40 mL/kg/day →**

~ 2775 to 3700 mL/day

- No HF, renal failure
- Considering some fluid losses through NG tube, IVPB meds → Will start patient on **2500 mL PPN**

~104.2 ml/hr

- Rph should communicate with the provider regarding discontinuation of existing maintenance fluid when PN begins infusing → current fluid 0.9% NaCl running at 75 ml/hr will be discontinued when PPN infusion starts

Fluid/Nutrition Summary For Order

The values shown are based on the patient receiving 1 bags over 24 hours.

Order Details

Infusion Rate (mL/hr)	104.2
Infusion Site	Peripheral
Weight Used (Recorded) (kg)	92.5

Macronutrients

	Amount	Range	Total
Amino Acids (g)	85	70-105	85 g
Amino Acids (g/kg/dose)	0.92	--	85 g
Amino Acid Type	Plenamine		
Dextrose (g)	190	200-400	190 g
Glucose Infusion Rate (mg/kg/min)	1.43	<=5	
Non-Protein (kcal): Nitrogen (g)	47.5	--	

Energy Contribution

	Kcal/kg/dose	kcal	%
Protein	3.68	340	34.48
Dextrose	6.98	646	65.52
Lipids	--	--	--
Total	10.66	986	

Electrolytes

Cations	Amount	Range	Total
Sodium (mEq)	200	40-100	200 mEq
Sodium (mEq/L)	80	--	200 mEq
Potassium (mEq)	25	20-80	25 mEq
Calcium (mEq)	5	5-20	5 mEq
Magnesium (mEq)	8	4-16	8 mEq
Anions			
Phosphate (mmol)	15	10-40	15 mmol
Chloride (mEq)	205	--	205 mEq
Acetate (mEq)	--	--	--
Chloride: Acetate Ratio	--	--	

Additives

	Amount	Range
Famotidine (mg)	--	--
Heparin (Units)	--	--
Insulin (Units)	--	--

Mixture Compatibility

		Range
Osmolarity	897.33	<=900
Calcium Phosphate Solubility Curve (mEq of Calcium)	5	<=3,875

Recommended ≤4.25% amino acid concentration in PPN

Amino Acids (Selection Required) + Add

amino acids (start conc 15%) 85 g

Calc. dose: 85 g

Dextrose (Selection Required) + Add

dextrose (start conc 70%) 190 g

Calc. dose: 271.43 mL

Electrolytes + Add

☑ sodium phosphates	15	mmol	15 mmol
☑ sodium chloride	180	mEq	40 mEq
☐ sodium acetate			
☐ potassium phosphate			
☑ potassium chloride	25	mEq	20 mEq 40 mEq
☐ potassium acetate			
☑ magnesium sulfate	8	mEq	4 mEq
	Calc. dose: 8 mEq		
☑ calcium gluconate	5	mEq	5 mEq
	Calc. dose: 5 mEq		

Key points:

- **PPN osmolarity should be less than 900 mOsm/L**
- **Amino acid ~0.92g/kg/dose (acceptable unable to increase due to osmolarity limitation)**
- **Continue to replete phosphate, potassium, magnesium in PPN**
- **Based on sodium content per liter, bag similar to ~ 0.45% NaCl (77 mEq/L)**

Day 2: Continue PPN

- Patient still obstructed ; NG output remains high

	Day 1	Day 2
Lab	Value	Value
Na	136 mEq/L	135 mEq/L
K	3.2 mEq/L	3.4 mEq/L
Cl	95 mEq/L	99 mEq/L
HCO3	28 mEq/L	27 mEq/L
Mg	1.8 mg/dL	2 mg/dL
PO4	2.1 mg/dL	2.5 mg/dL
Ca	8.4 mg/dL	8.3 mg/dL
Albumin	2.7 mg/dL	2.6 mg/dL
SCr	1.1 mg/dl	1.2 mg/dl
Glucose	111 mg/dL	135 mg/dL

- Reorder same PPN bag for day 2

Day 3: Transition to TPN

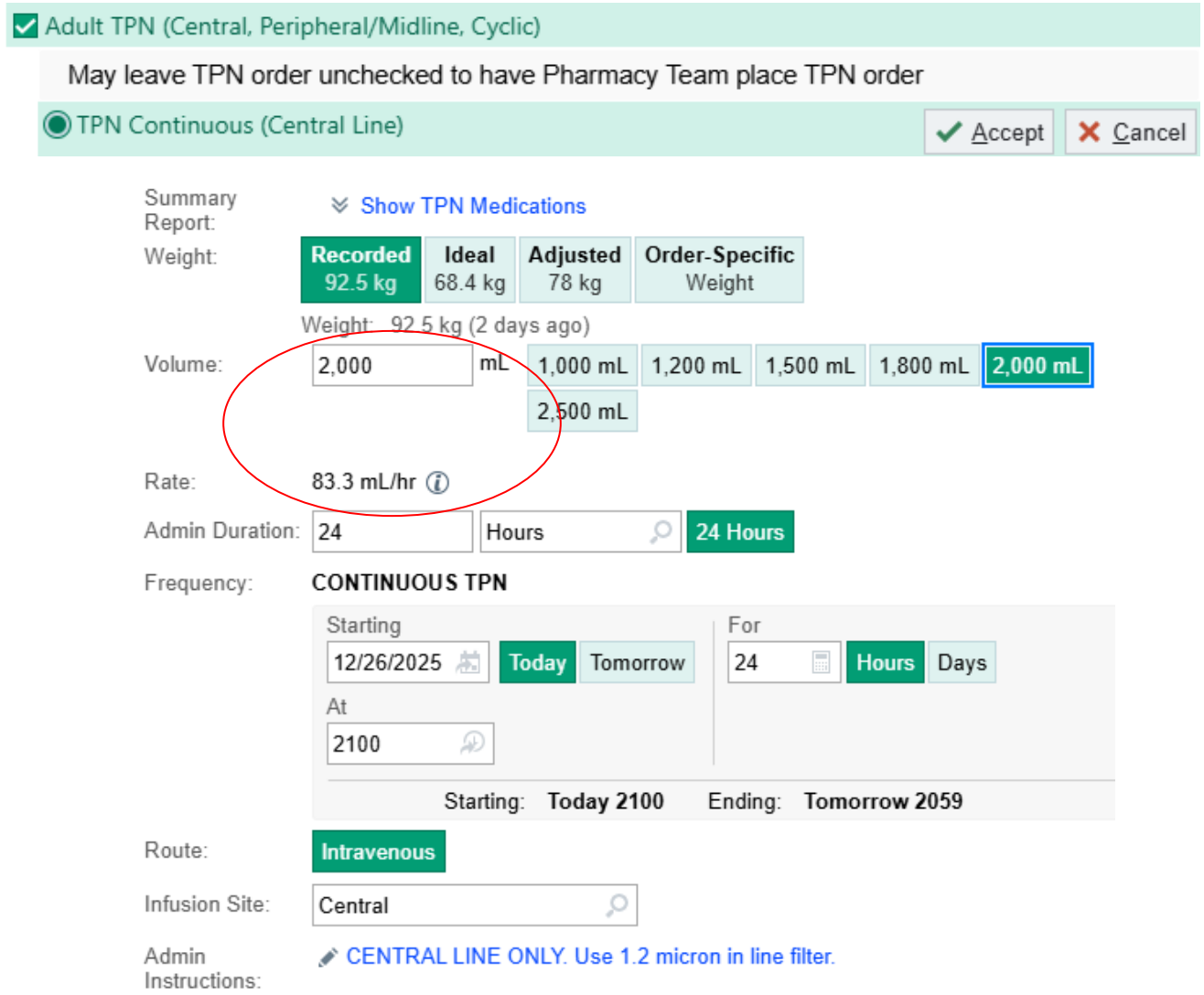
- SBO persists. Surgery teams anticipate prolonged NPO status >7day
- Central line placed by Vascular Access Team
- Macronutrient recommendation by Registered Dietician (RD):

TPN suggested goal of 300g dextrose, 130 g AA, 50 g lipids =
2040 kcal/day (Based on 30 kcal/kg IBW, ~2 g/kg IBW, ~25% lipids)

TPN Initiation – Review of Macronutrients

- Protein
  - Start at goal
- Dextrose
  - Start 150–200 g/day (or 50% of dextrose goal)
  - Consider 100g if hyperglycemia
  - Titration: increase to goals over 3 – 5 days
  - Consider hyperglycemia or refeeding syndrome when up-titrating dextrose
  - Consider glucose infusion rate (GIR)
- Fluids
  - Adjust based on fluid status change as discussed with providers

Day 3: Initiate TPN



- Review of I&O – NG output decreased
- Start TPN at 83.3 ml/hr (may adjust based on fluid status change as discussed with providers)

	Day 1	Day 2	Day 3
Lab	Value	Value	Value
Na	136 mEq/L	135 mEq/L	136 mEq/L
K	3.2 mEq/L	3.4 mEq/L	3.6 mEq/L
Cl	95 mEq/L	99 mEq/L	104 mEq/L
HCO3	28 mEq/L	27 mEq/L	28 mEq/L
Mg	1.8 mg/dL	2 mg/dL	1.9 mg/dL
PO4	2.1 mg/dL	2.5 mg/dL	2.9 mg/dL
Ca	8.4 mg/dL	8.3 mg/dL	8.3 mg/dL
Albumin	2.7 mg/dL	2.6 mg/dL	2.5 mg/dL
SCr	1.1 mg/dl	1.2 mg/dl	1.2 mg/dl
Glucose	111 mg/dL	135 mg/dL	152 mg/dL

Day 3: Initiate TPN

Fluid/Nutrition Summary For Order

The values shown are based on the patient receiving 1 bags over 24 hours.

Order Details

Infusion Rate (mL/hr)	83.3
Infusion Site	Central
Weight Used (Recorded) (kg)	92.5

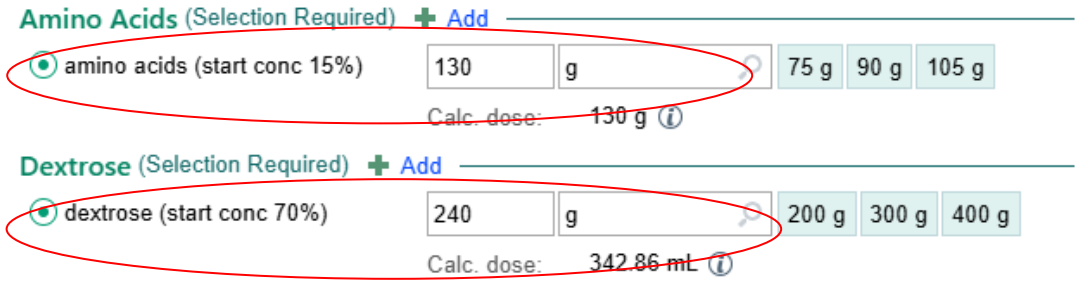
Macronutrients

	Amount	Range	Total
Amino Acids (g)	**130**	**70-105**	**130 g**
Amino Acids (g/kg/min)	0.01	--	130 g
Amino Acids (g/kg/dose)	1.41	--	130 g
Amino Acid Type	Plenamine		
Dextrose (g)	240	--	240 g
Glucose Infusion Rate (mg/kg/min)	1.8	<=5	
Non-Protein (kcal): Nitrogen (g)	39.23	--	

Energy Contribution

	Kcal/kg/dose	kcal	%
Protein	5.62	520	38.92
Dextrose	8.82	816.01	61.08
Lipids	--	--	--
Total	14.44	1,336.01	

Note: EPIC Summary View reports amino acid g/kg/dose based on actual body weight



Macronutrient titration:

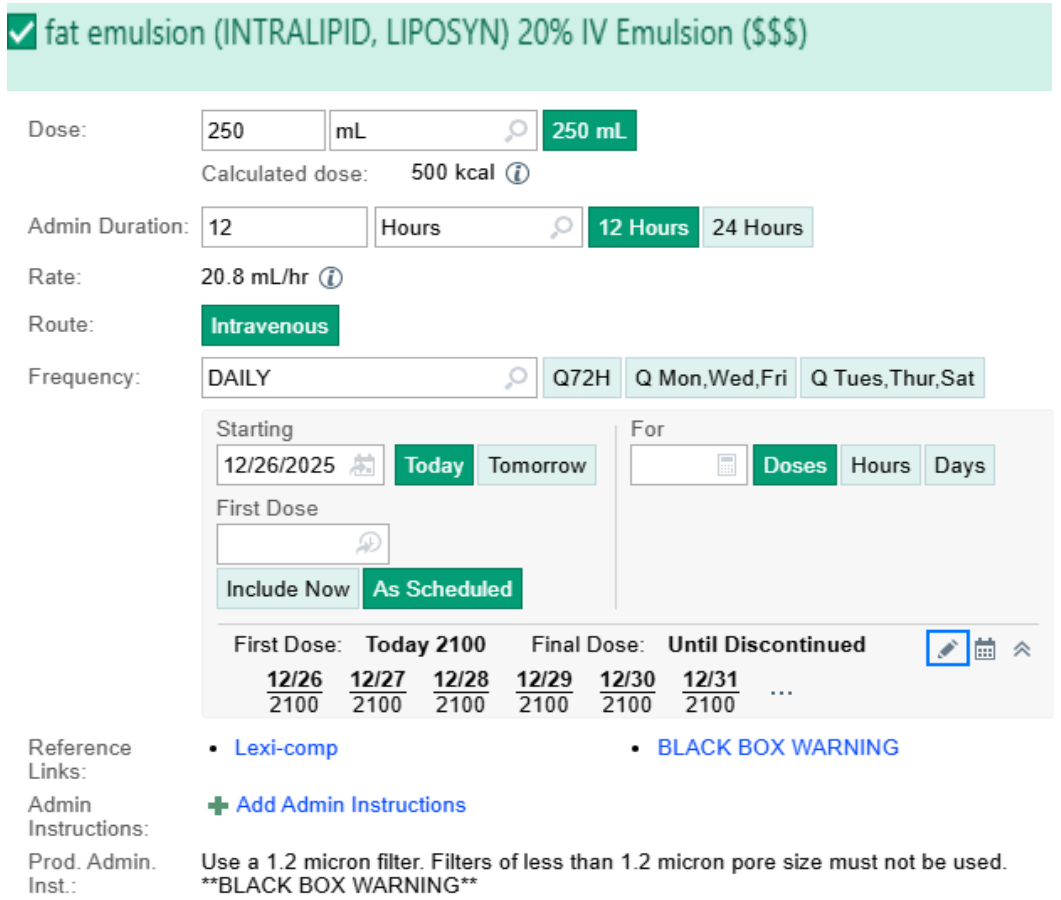
- Increase AA to goal per RD rec ~2 g/kg IBW: 130g
- Consideration for advancing dextrose:
  - Blood sugar level, goal 140-180 mg/dL
  - GIR < 5 mg/kg/min
  - Advance ~33% of goal every 1-2 day
  - Ensure intracellular electrolytes (Phos, K+, Mg ++) are stable before advancing dextrose
- Increase dextrose from 190g to 240g

Order Lipids Separately

	Latest Reference Range & Units	12/24/25 04:51
Triglycerides	<150 mg/dL	126

Based on RD macronutrient recommendation: Will order Intralipid 50g daily at 2100 to infuse over 12 hours

**Reminder always round to whole bag size **



Electrolytes Review

Sodium (Na)

General initiation and recommended max	Clinical and co-morbidities consideration for initial dose		Titration and other considerations
Initial general range: 38-77 mEq/L Typical requirement: 1-2 mEq/kg per day High dose threshold: 200 mEq/L	Higher dose range (≥120-130 mEq/L)	• Cerebral salt-wasting • High output fistula • Short bowel syndrome • Severe diarrhea <u>Concomitant meds</u>: Ampicillin ampicillin/sulbactam Cefiderocol Linezolid meropenem-vaborbactam oxacillin penicillin G sodium	<u>Titrate slowly</u>. Serum Na should not fluctuate by 8 mEq/L per day Before replacement, review for dilutional causes of hyponatremia (i.e. excessive free water administration, fluid overload, HF, ascites, etc.)
	Lower dose range (<38mEq/L)	• Heart failure • Edema/anasarca • Ascites • Hypernatremia • Refeeding syndrome	

https://www.ashp.org/-/media/assets/pharmacy-practice/resource-centers/Clinical-Pharmacy-Resources/Nutrition-Support/2016-MCM/MCM16-335-Strategies-for-Successful-Parenteral-nutrition.ashx?la=en&hash=D54060FF097639F8BCE810095FF550EDDC3B2C18

Potassium (K)

General initiation and recommended max	Clinical and co-morbidities consideration for initial dose		Titration and other considerations
Typical requirement: 1-2 mEq/kg per day High dose threshold: 240 mEq per day	Higher dose range (>2 mEq/kg/day)	• Metabolic alkalosis • Poor intake • Hypokalemia • Refeeding Syndrome • Hypomagnesemia	Every 10 mEq of K is expected to increase serum level by ~ 0.1 mEq/L Supplemental potassium administered outside of PN bag must be considered when adjusting K in PN bag
	Lower dose range (<0.5 – 1 mEq/kg/day)	• Metabolic acidosis • Renal failure • Excessive intake • Hyperkalemia • Tumor lysis syndrome	Do not infuse faster than 20 mEq/hr (or 10 mEq/hr without cardiac monitoring)

https://www.ashp.org/-/media/assets/pharmacy-practice/resource-centers/Clinical-Pharmacy-Resources/Nutrition-Support/2016-MCM/MCM16-335-Strategies-for-Successful-Parenteral-nutrition.ashx?la=en&hash=D54060FF097639F8BCE810095FF550EDDC3B2C18

Concomitant meds with Potassium

- **Higher dose consider for:**
  - Beta-agonists, insulin, amphotericin B, diuretics, hydrocortisone
- **Lower dose consider for:**
  - ACEI/ARB, cyclosporine, tacrolimus, K-sparing diuretics, NSAIDs, trimethoprim
- **Pharmacist may order GEN hypokalemia order set with appropriate renal function considerations per order set parameters**
- **Narrow therapeutic index**

https://www.ashp.org/-/media/assets/pharmacy-practice/resource-centers/Clinical-Pharmacy-Resources/Nutrition-Support/2016-MCM/MCM16-335-Strategies-for-Successful-Parenteral-nutrition.ashx?la=en&hash=D54060FF097639F8BCE810095FF550EDDC3B2C18

Calcium (Ca)

General initiation and recommended max	Clinical and co-morbidities consideration for initial dose		Titration and other considerations
Typical requirement: 10-15 mEq per day High dose threshold: 40 mEq per day	Higher initial dose	• Severe hypocalcemia • Severe pancreatitis • Parathyroidectomy • Vitamin D deficiency Concomitant meds: • Foscarnet • Pentamidine	Determine corrected calcium prior to making adjustment: Corrected Calcium = Serum Calcium + 0.8 * (4 - Serum Albumin) Assess calcium-phosphorous curves Mild fluctuation of serum calcium levels should not impact calcium adjustment in PN Calcium supplement is generally required in prolonged NPO
	Lower initial dose	• Hypercalcemia • Hyperphosphatemia • Metastatic cancer • Prolonged immobilization	

https://www.ashp.org/-/media/assets/pharmacy-practice/resource-centers/Clinical-Pharmacy-Resources/Nutrition-Support/2016-MCM/MCM16-335-Strategies-for-Successful-Parenteral-nutrition.ashx?la=en&hash=D54060FF097639F8BCE810095FF550EDDC3B2C18

Magnesium (Mg)

General initiation and recommended max	Clinical and co-morbidities consideration for initial dose		Titration and other considerations
Typical requirement: 8-20 mEq per day High dose threshold: 45 mEq per day	Higher initial dose (> 0.5 mEq/kg/day)	• Alcohol abuse • Diarrhea • Hypomagnesemia • Refeeding syndrome	Every 8 mEq of Mg is expected to increase serum level by ~ 0.1 mg/dL Supplemental magnesium administered must be considered when adjusting Mg in PN bag Wide therapeutic index
	Lower initial dose (< 0.25 mEq/kg/day)	• Renal failure • Excessive intake • Hypermagnesemia • Tumor lysis syndrome	

https://www.ashp.org/-/media/assets/pharmacy-practice/resource-centers/Clinical-Pharmacy-Resources/Nutrition-Support/2016-MCM/MCM16-335-Strategies-for-Successful-Parenteral-nutrition.ashx?la=en&hash=D54060FF097639F8BCE810095FF550EDDC3B2C18

Concomitant meds with Magnesium

- **Higher dose consider for:**
  - Aminoglycosides, amphotericin B, diuretics (loop/thiazide), cyclosporin, tacrolimus, cisplatin, insulin, foscarnet, PPIs (chronic)
- **Lower dose consider for:**
  - Mg-containing antacids, lithium
- **Pharmacist may order HOSP Magnesium Replacement order set with appropriate renal function considerations per order set parameters**

https://www.ashp.org/-/media/assets/pharmacy-practice/resource-centers/Clinical-Pharmacy-Resources/Nutrition-Support/2016-MCM/MCM16-335-Strategies-for-Successful-Parenteral-nutrition.ashx?la=en&hash=D54060FF097639F8BCE810095FF550EDDC3B2C18

Phosphate (PO_4)

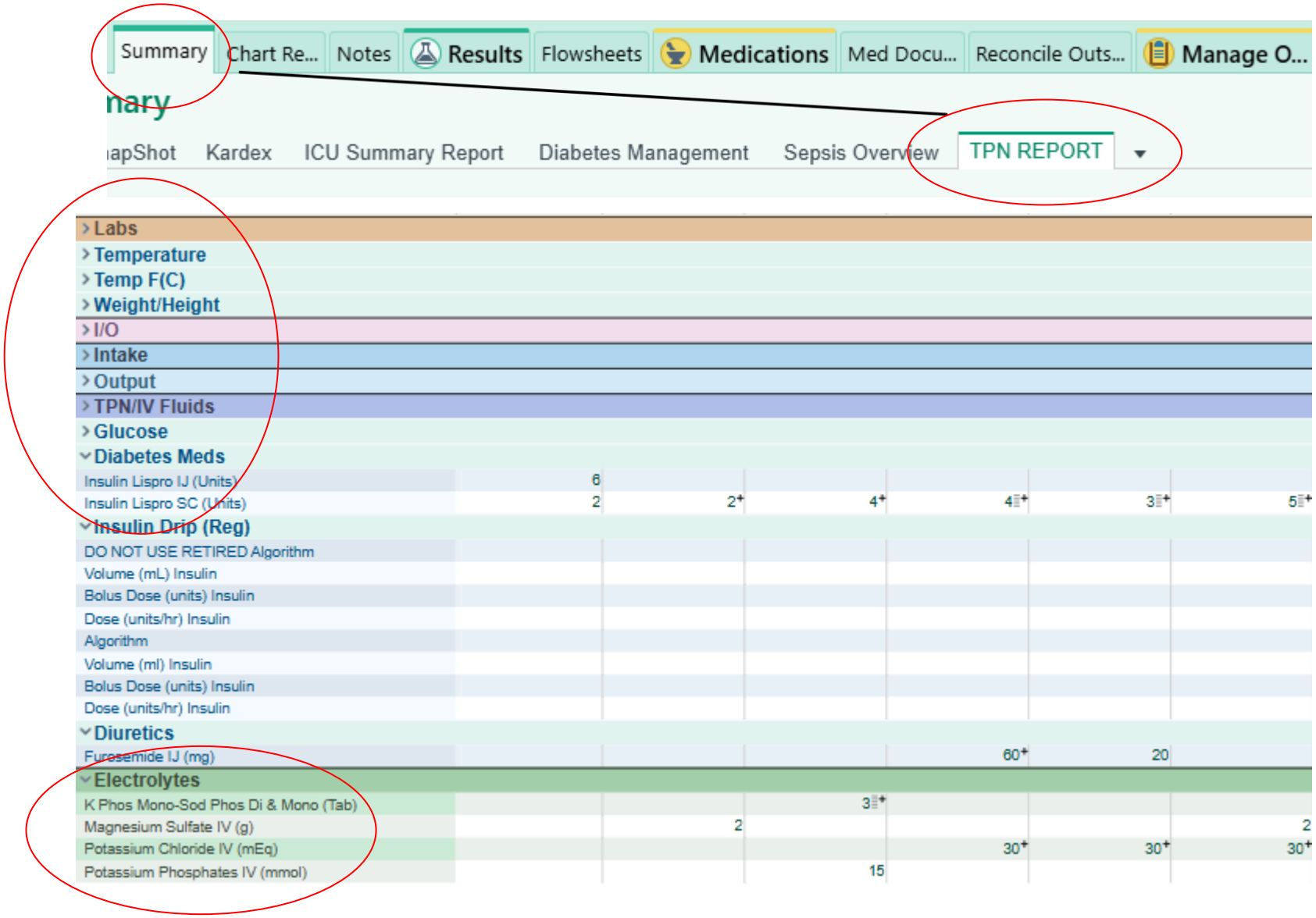
General initiation and recommended max	Clinical and co-morbidities consideration for initial dose		Titration and other considerations
Typical requirement: 20-40 mmol per day High dose threshold: 65 mmol per day	Higher initial dose (>0.25-0.5 mmol/kg/day)	• Alcohol abuse • Chronic malnutrition • Hypophosphatemia • Refeeding syndrome	Every 20 mmol of PO_4 is expected to increase serum level by ~ 1 mg/dL Supplemental phosphate administered outside of PN bag must be considered when adjusting PO_4 in PN bag Assess $CaPO_4$ curve Provide as either Na or K salt
	Lower initial dose (<0.25 mmol/kg/day)	• Renal failure • Hyperphosphatemia • Tumor lysis syndrome	

https://www.ashp.org/-/media/assets/pharmacy-practice/resource-centers/Clinical-Pharmacy-Resources/Nutrition-Support/2016-MCM/MCM16-335-Strategies-for-Successful-Parenteral-nutrition.ashx?la=en&hash=D54060FF097639F8BCE810095FF550EDDC3B2C18

Chloride/Acetate ratio

Acetate > Chloride	Chloride > Acetate
- Metabolic acidosis - Severe diarrhea - High output fistula - Renal bicarbonate wasting - Short bowel syndrome	- Metabolic alkalosis - Severe vomiting - Large nasogastric losses - Diuretic use (loop/thiazide) - Dehydration

https://www.ashp.org/-/media/assets/pharmacy-practice/resource-centers/Clinical-Pharmacy-Resources/Nutrition-Support/2016-MCM/MCM16-335-Strategies-for-Successful-Parenteral-nutrition.ashx?la=en&hash=D54060FF097639F8BCE810095FF550EDDC3B2C18



Accordion Report "SH RX TPN Report":

- Displays: labs, temperature, weight/height, I&O, TPN/IV fluids, blood glucose levels, insulin administration record, diuretics, electrolytes administration
- Allows quick review of electrolytes administered last 24 hours for assessment how to adjust electrolyte amounts in TPN for that evening

Electrolytes

Intracellular electrolytes must be considered first: potassium, magnesium, and phosphate

- During starvation or catabolism, intracellular stores become depleted while serum levels may appear “normal”
- TPN initiation rapidly reverses catabolism to anabolism, forcing electrolytes back into cells and unmasking deficits
  - When TPN is started especially dextrose, increase in glucose → increase in insulin secretion → causes rapid intracellular shifts
- Decreasing serum phosphate, potassium, magnesium levels after TPN initiation may be due to refeeding and these electrolytes must be repleted and serum level maintained
  - Phosphate > 3 mg/dL
  - Potassium > 4 mEq/L
  - Magnesium > 2 mg/dL

Patient Case
TPN Initiation – Electrolytes

- **Electrolytes Replaced Last 24hrs:**
  - 15 mmol potassium phosphate
- **Electrolyte adjustments**
  - Phosphate: based on serum level, may increase by 5 mmol from PPN - add as 20 mmol K^3PO_4

    Note: 1 mmol K^3PO_4 = 1.5 mEq K+

    1 mmol Na^3PO_4 = 1.33 mEq Na+
  - Potassium: added as potassium phosphate will give ~30 mEq K+ in bag
  - Magnesium: increase to 16 mEq in TPN

    Note: 8 mEq Mg++ = 1 gm of magnesium sulfate

	Day 1	Day 2	Day 3
Lab	Value	Value	Value
Na	136 mEq/L	138 mEq/L	139 mEq/L
K	3.2 mEq/L	3.4 mEq/L	3.6 mEq/L
Cl	95 mEq/L	99 mEq/L	104 mEq/L
HCO3	28 mEq/L	27 mEq/L	28 mEq/L
Mg	1.8 mg/dL	2 mg/dL	1.9 mg/dL
PO4	2.1 mg/dL	2.5 mg/dL	2.9 mg/dL
Ca	8.4 mg/dL	8.3 mg/dL	8.3 mg/dL
Albumin	2.7 mg/dL	2.6 mg/dL	2.5 mg/dL
SCr	1.1 mg/dl	1.2 mg/dl	1.2 mg/dl
Glucose	111 mg/dL	135 mg/dL	152 mg/dL

Patient Case
TPN Initiation – Electrolytes

Fluid/Nutrition Summary For Order

The values shown are based on the patient receiving 1 bags over 24 hours.

Order Details

Infusion Rate (mL/hr)	83.3
Infusion Site	Central
Weight Used (Recorded) (kg)	92.5

Macronutrients

	Amount	Range	Total
Amino Acids (g)	130	70-105	130 g
Amino Acids (g/kg/min)	0.01	--	130 g
Amino Acids (g/kg/dose)	1.41	--	130 g
Amino Acid Type	Plenamine		
Dextrose (g)	240	--	240 g
Glucose Infusion Rate (mg/kg/min)	1.8	<=5	
Non-Protein (kcal): Nitrogen (g)	39.23	--	

Energy Contribution

	Kcal/kg/dose	kcal	%
Protein	5.62	520	38.92
Dextrose	8.82	816.01	61.08
Lipids	--	--	--
Total	14.44	1,336.01	

Electrolytes

Cations	Amount	Range	Total
Sodium (mEq)	180	40-100	180 mEq
Sodium (mEq/L)	90	--	180 mEq
Potassium (mEq)	39.33	20-80	39.33 mEq
Calcium (mEq)	10	5-20	10 mEq
Magnesium (mEq)	16	4-16	16 mEq
Anions			
Phosphate (mmol)	20	10-40	20 mmol
Chloride (mEq)	190	--	190 mEq
Acetate (mEq)	--	--	--
Chloride: Acetate Ratio	--	--	

Additives

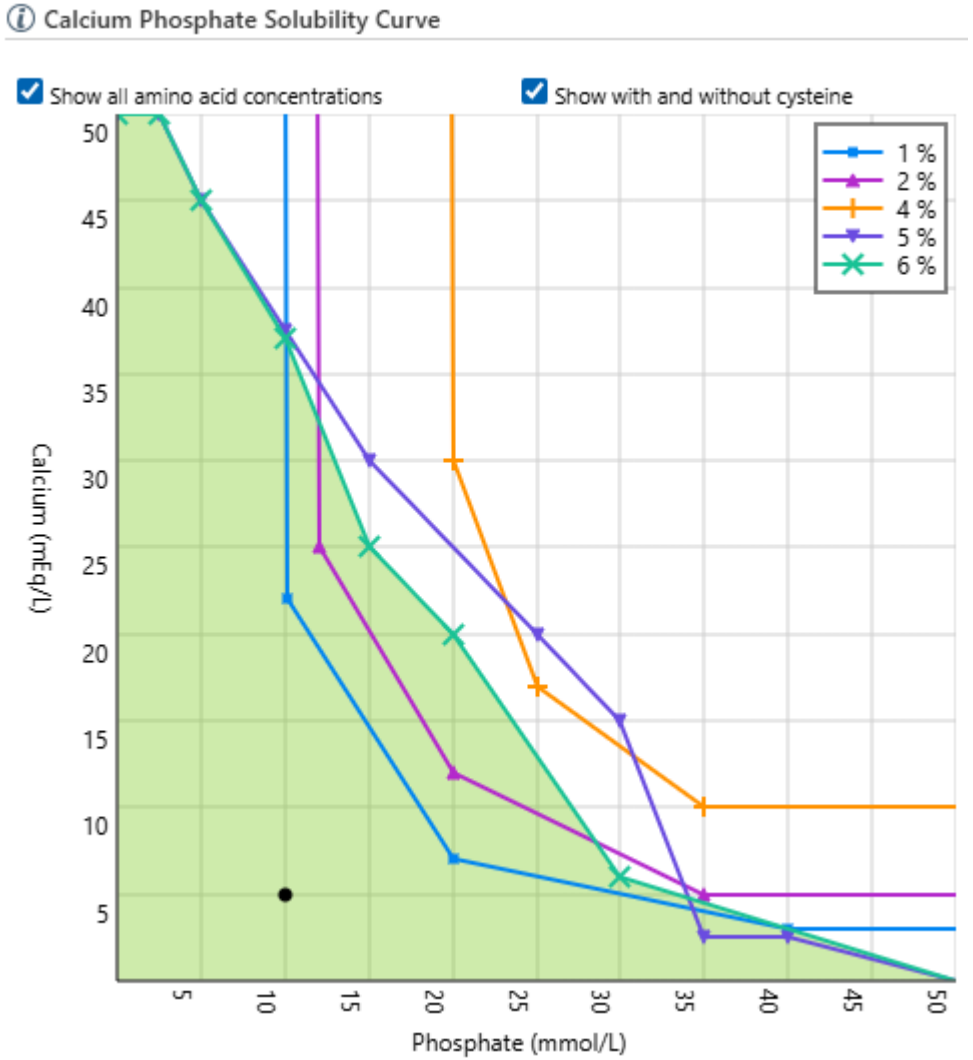
	Amount	Range
Famotidine (mg)	--	--
Heparin (Units)	--	--
Insulin (Units)	--	--

Mixture Compatibility

		Range
Osmolarity	1,455.01	--
Calcium Phosphate Solubility Curve (mEq of Calcium)	10	<=74.2

Electrolytes + Add

- ☐ sodium phosphates
- ☑ sodium chloride — 180 mEq — 40 mEq | 60 mEq | 80 mEq | 100 mEq
- ☐ sodium acetate
- ☑ potassium phosphate — 20 mmol — 10 mmol | **20 mmol** | 30 mmol | 40 mmol
  - Calc. dose: 20 mmol ⓘ
- ☑ potassium chloride — 10 mEq — 20 mEq | 40 mEq | 60 mEq | 80 mEq
- ☐ potassium acetate
- ☑ magnesium sulfate — 16 mEq — 4 mEq | 8 mEq | 12 mEq | **16 mEq**
  - Calc. dose: 16 mEq ⓘ
- ☑ calcium gluconate — 10 mEq — 5 mEq | **10 mEq** | 15 mEq | 20 mEq
  - Calc. dose: 10 mEq ⓘ



CaPO4 Solubility Curve:

- The calcium phosphate solubility curve illustrates the relationship between calcium and phosphate Concentrations in solution, indicating the conditions under which precipitation may occur.
- The curve plots calcium concentration (mEq/L) against phosphate concentration (mmol/L). Each curve represents the maximum solubility for a Specific amino acid concentration in TPN solution.
- **If the calculated concentration of calcium and phosphate (represented by a point on the graph) fall to the right of the curve, precipitation is likely to occur.**

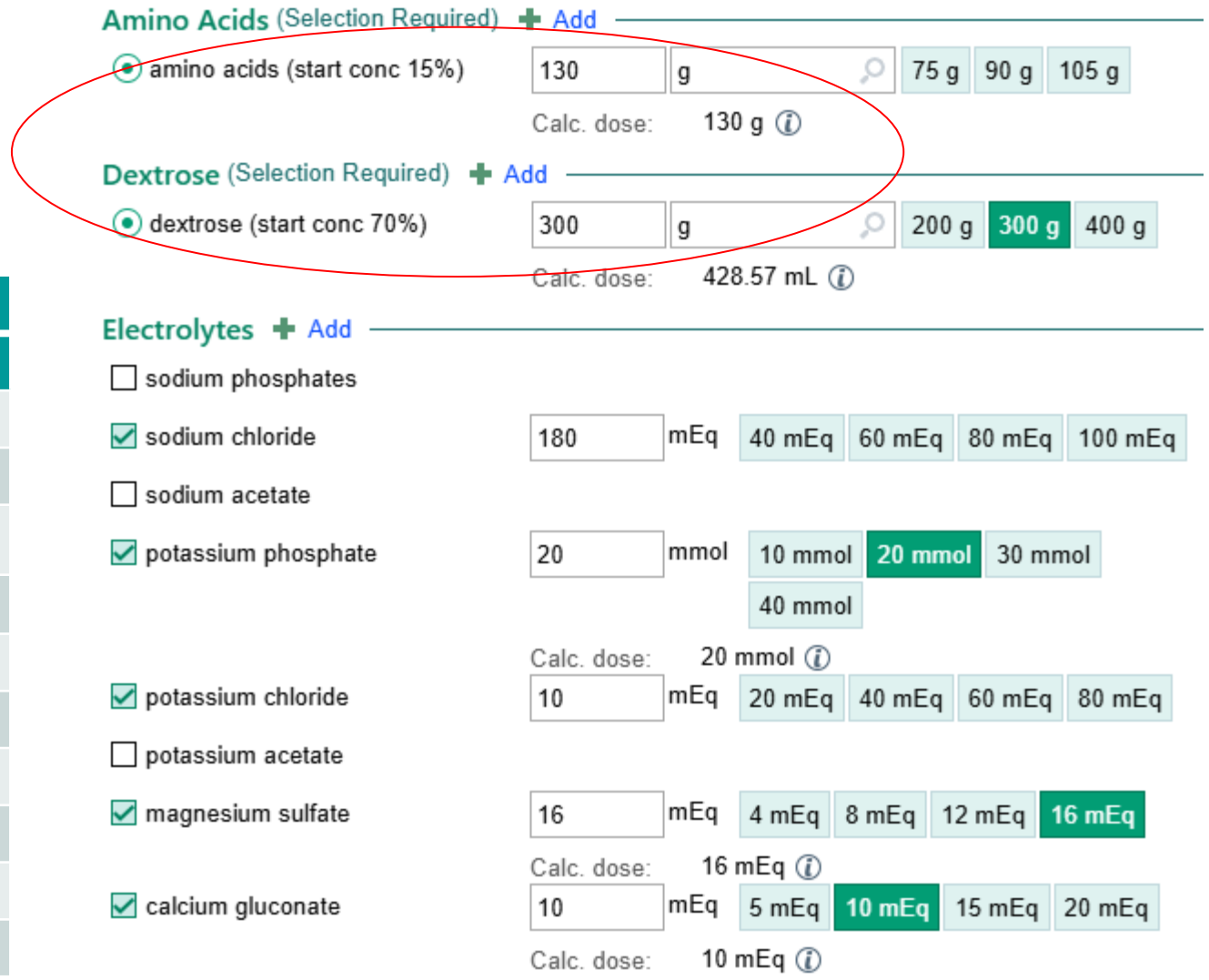
Ongoing TPN Adjustments

- **Advancing dextrose in TPN**
  - Assess blood glucose levels, refrain from advancing dextrose if uncontrolled
  - Ensure intracellular electrolytes repleted prior to advancing dextrose
- **Electrolyte adjustments**
  - Review TPN Accordion Report to assess electrolytes replaced in the last 24 hours
  - Phosphate – adjust increments of 5-10 mmol/L depending on serum levels, may need to increase more in refeeding
  - Potassium – increase by up to 50% of the amount replaced in the past 24 hours (depending on serum levels 25% increase may be appropriate)
  - Magnesium – increase by up to 50% of the amount replaced in the past 24 hours
  - Sodium – 20-30 mEq/L change is expected to raise or lower serum sodium levels by 3-4 mEq/L

Day 4: Titrate TPN to goal

TPN suggested goal of 300g dextrose, 130 g AA, 50 g lipids = 2040 kcal/day (Based on 30 kcal/kg IBW, ~2 g/kg IBW, ~25% lipids)

	Day 1	Day 2	Day 3	Day 4
Lab	Value	Value	Value	Value
Na	136 mEq/L	138 mEq/L	139 mEq/L	140 mEq/L
K	3.2 mEq/L	3.4 mEq/L	3.6 mEq/L	4 mEq/L
Cl	95 mEq/L	99 mEq/L	104 mEq/L	103 mEq/L
HCO3	28 mEq/L	27 mEq/L	28 mEq/L	26 mEq/L
Mg	1.8 mg/dL	2 mg/dL	1.9 mg/dL	2.1 mg/dL
PO4	2.1 mg/dL	2.5 mg/dL	2.9 mg/dL	3.4 mg/dL
Ca	8.4 mg/dL	8.3 mg/dL	8.3 mg/dL	8.3 mg/dL
Albumin	2.7 mg/dL	2.6 mg/dL	2.5 mg/dL	2.5 mg/dL
SCr	1.1 mg/dl	1.2 mg/dl	1.2 mg/dl	1.2 mg/dl
Glucose	111 mg/dL	135 mg/dL	152 mg/dL	152 mg/dL



Glycemic Control

Insulin Management

Glycemic Control (Insulin management)

Blood glucose monitoring and subcutaneous insulin management

- For patients who did **not** receive insulin prior to PN initiation, ensure POC glucose is q4h
- Pharmacist must review existing insulin regimen at the initiation of PN
  - Pharmacist may initiate subcutaneous insulin correctional orders following GEN SUBCUTANEOUS INSULIN order set guidance.
  - Nutritional insulin should be discontinued if patient is not provided enteral nutrition
  - Basal or intermediate-acting insulin may be continued if appropriate
  - Adjustment of nutritional, basal and intermediate-acting insulin doses must be consulted with the provider

Glycemic Control (Insulin management)

Key Principles for Insulin Titration in TPN

- Insulin should be added directly to the TPN solution when patients have required >40 units of insulin in the past 24 hours.
- This approach is the safest method to prevent hypoglycemia if TPN is stopped or interrupted, as the insulin and dextrose are discontinued simultaneously.
- Dextrose infusions should not be advanced when glucose is not at goal, as this creates a counter productive cycle of worsening hyperglycemia that confounds insulin titration.

Glycemic Control (Insulin management)

Tapering and transition

- Upon PN tapering or transitioning to EN, any insulin added to PN must be adjusted
- Transition of insulin subcutaneous basal or nutritional regimen should follow the GEN SUBCUTANEOUS INSULIN order set guidance and consult with the provider

Glycemic Control (Insulin management)

Target Blood Glucose range: 140-180 mg/dL

Consider if glycemic control not optimized despite subcutaneous insulin adjustments for patient requires high dose insulin (> 40 units total daily dose or TDD)

- •Studies comparing regular insulin added to TPN versus subcutaneous insulin glargine have demonstrated that insulin added to TPN achieves superior glycemic control (71.8% vs 48.6% achieving target glucose, P=0.017) with comparable or lower hypoglycemia rates, particularly in patients with diabetes

Adding insulin to PN bag

- Initial addition of insulin to PN bag must be consulted with the provider
- Pharmacist may adjust subsequent insulin dose in the PN bag
  - Discontinue nutritional insulin as appropriate.
- Pharmacist may add up to 50% of total daily dose (TDD) of insulin PN bag. Amount higher than 50% of TDD must be approved by provider
- No more than 100 units of insulin should be added to PN
- Insulin should not be added to PN bag if patient is receiving IV insulin continuous infusion

Patient Case: Insulin-Naive Patient on TPN with Hyperglycemia

A **70-kg adult M with no prior diabetes or insulin use** has been receiving TPN containing 150 g of carbohydrates daily. Patient continues to receive POC glucose q4h with average insulin correction scale .

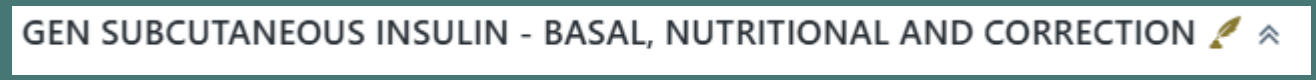
- Despite no history of glucose intolerance, the patient has developed persistent hyperglycemia requiring escalating correctional insulin, with a **total daily dose (TDD) of 60 units over 24 hours**.
  - This degree of insulin requirement in a previously insulin-naive patient reflects stress hyperglycemia and insulin resistance.

Patient Case: Insulin-Naive Patient on TPN with Hyperglycemia

A 70-kg adult with no prior diabetes or insulin use has been initiated on continuous TPN containing 150 g of carbohydrates.

Day 1: Glucose Pattern	
Time	POC (mg/dL)
2000	305
0000	308
0400	302
0800	304
1200	305
1600	301

- ☑ For patients who did not receive insulin prior to PN initiation, the pharmacist must order **POC q4h**.
- ☑ Consulted provider to begin correctional insulin
  - Ordered Average insulin correction q4hrs



Patient Case: Insulin-Naive Patient on TPN with Hyperglycemia

A 70-kg adult with no prior diabetes or insulin use has been receiving continuous TPN containing 150 g of carbohydrates daily for *3 days*. Patient continues to receive POC glucose q4h with average insulin correction scale.

Day 3 Glucose Pattern and Correctional Insulin Requirements		
Time	POC (mg/dL)	Unit
2000	253	6 units
0000	310	10 units
0400	252	6 units
0800	280	6 units
1200	254	6 units
1600	308	10 units

- Assessment
  - TDD of 44 units utilized since the change in bag
    - For insulin-naive patients with type 2 diabetes or stress hyperglycemia, the American Association of Clinical Endocrinology **recommends starting insulin TDD between 0.3–0.5 units/kg/day.**
  - For this 70-kg patient, this would translate to 21–35 units daily, which aligns with the observed requirement of 44 units when accounting for the stress of acute illness.

Patient Case: Insulin-Naive Patient on TPN with Hyperglycemia

A 70-kg adult with no prior diabetes or insulin use has been receiving TPN containing 150 g of carbohydrates daily for 3 days. Patient continues to receive POC glucose q4h with average insulin correction scale.

Day 3 Glucose Pattern and Correctional Insulin Requirements		
Time	POC (mg/dL)	Unit
0000	253	6 units
0400	310	10 units
0800	252	6 units
1200	280	6 units
1600	254	6 units
2000	308	10 units

- Assessment:
  - Consider adding insulin into TPN if glycemic control not optimized despite subcutaneous insulin adjustments or patient requires high dose insulin (> 40 units total daily dose or TDD)
    - Per ADA guidelines, consider starting at 1 unit of regular human insulin for every 10 g of dextrose in the TPN formulation

Patient Case: Insulin-Naive Patient on TPN with Hyperglycemia

A 70-kg adult with no prior diabetes or insulin use has been receiving TPN containing 150 g of carbohydrates daily for 3 days. Patient continues to receive POC glucose q4h with average insulin correction scale.

Day 3 Glucose Pattern and Correctional Insulin Requirements

Time	POC (mg/dL)	Unit
0000	253	6 units
0400	310	10 units
0800	252	6 units
1200	280	6 units
1600	254	6 units
2000	308	10 units

- Plan:
  - Discussed with provider, okay to add insulin in TPN, and continuing sliding scale
  - Will add 15 units of regular insulin and continue subq correctional insulin q4hrs with insulin lispro
    - Correctional insulin used to address breakthrough hyperglycemia that exceeds target glucose levels

Patient Case: Insulin-Naive Patient on TPN with Hyperglycemia

A 70-kg adult with no prior diabetes or insulin use has been receiving TPN containing 150 g of carbohydrates daily for 3 days. Patient continues to receive POC glucose q4h with average insulin correction scale.

Day 3 Glucose Pattern and Correctional Insulin Requirements		
Time	POC (mg/dL)	Unit
0000	253	6 units
0400	310	10 units
0800	252	6 units
1200	280	6 units
1600	254	6 units
2000	308	10 units

- Special Considerations:
  - **Target glucose range of 140–180 mg/dL**
  - **Dextrose should not be advanced when glucose remains above goal**, as this worsens hyperglycemia and undermines insulin titration efforts.
  - If TPN is interrupted, consider **initiating dextrose 10% infusion at 50 mL/hour** to prevent hypoglycemia in patients receiving insulin-containing TPN, as the insulin and dextrose will no longer be synchronized.
  - Minimum amount on 5 units of regular insulin is required to prevent insulin adsorption (adhesion) to the TPN bag and tubing

Transitioning to and from enteral feeding

Transitioning PN to enteral feeding

Follow these steps once enteral nutrition is started and the TPN is ready to be weaned:

1. Consult with registered dietitian as needed
2. Taper PN as enteral nutrition is advanced (combination should meet estimated demand needs)
   - **Routinely assess gastrointestinal function** for readiness to begin or advance oral or enteral intake
   - **Verify metabolic and clinical stability** on current PN regimen before initiating transition
3. Once oral diet or enteral nutrition meets 60% of calorie needs, discuss with ordering provider to obtain order to taper and/or discontinue PN
4. Upon decision to taper and discontinue PN, pharmacist should decrease PN infusion rate by 50% for at least 1-2 hours or until content of the bag is empty before discontinuing to reduce rebound hyperglycemia. In addition, pharmacist should discontinue appropriate RX Communication order, lipid order, and associative labs in EPIC if not done by the provider.
   - Pharmacist will review any additives in the PN order and evaluate if separate orders are needed (e.g. H2RA, thiamine, zinc, insulin etc.)

   Note: If PN needs to be stopped immediately or inadvertently interrupted, ensure D10W is ordered to be infused at the same rate as PN or a minimum of 50 ml/hr.

Cyclic consideration

Cyclic Considerations

Cyclic PN should be considered for patients with or at risk of liver dysfunction, those on long-term PN, and stable, active patients who may benefit from infusion-free time periods.

- by providing metabolic rest, improving bile flow, reducing lipid-induced hepatotoxicity, restoring normal hormonal cycling, and decreasing inflammation associated with continuous nutrient infusion

Specific patient populations who benefit include:

- To facilitate **Home PN patients** to allow freedom for daily activities and improved quality of life
- **Patients with PN-associated liver dysfunction (PNALD)**, where cycling may stabilize liver function tests in those with mild hyperbilirubinemia (<20 mg/dL)[3-4]
- **Patients transitioning to rehabilitation facilities** where infusion-free periods facilitate therapy participation
- **Prolonged weaning** from PN to oral feeding

Cyclic Considerations

Cyclic PN should be considered for patients with or at risk of liver dysfunction, those on long-term PN, and stable, active patients who may benefit from infusion-free time periods.

Cycling TPN leads to a greater rate of fluid and dextrose administration, proceed with caution in the following circumstances:

- CHF
- Pancreatitis
- Diabetes or hyperglycemia during acute illness/steroid use
- Unstable fluid status
- Glucose Infusion Rate (GIR) > 5 mg/kg/min

Cyclic Considerations

Cyclic PN should be considered for patients with or at risk of liver dysfunction, those on long-term PN, and stable, active patients who may benefit from infusion-free time periods.

Monitoring During Transition

- **Close patient monitoring during transition to cyclic PN is essential**.
- Key parameters include:
  - Daily on-cycle and off-cycle glucose monitoring during the transition period
  - Assessment for hyperglycemia, edema or weight gain, and/or fluid intolerance, which signal need for more cautious approach
  - Once tolerance is established, less frequent glucose monitoring may be acceptable, especially in stable home PN patients

Cyclic Considerations

Cyclic PN should be considered for patients with or at risk of liver dysfunction, those on long-term PN, and stable, active patients who may benefit from infusion-free time periods.

Monitoring During Transition

- **Close patient monitoring during transition to cyclic PN is essential**
- Key parameters include:
  - Daily on-cycle and off-cycle glucose monitoring during the transition period
  - Assessment for hyperglycemia, edema or weight gain, and/or fluid intolerance, which signal need for more cautious approach
    - Most Adult patients tolerate abrupt discontinuation of PN without experiencing rebound hypoglycemia. A 30-60 minute taper-down period is customarily, which perform this function automatically for added safety
  - Once tolerance is established, less frequent glucose monitoring may be acceptable, especially in stable home PN patients

Cyclic Considerations

Cyclic PN should be considered for patients with or at risk of liver dysfunction, those on long-term PN, and stable, active patients who may benefit from infusion-free time periods.

Monitoring During Transition

- **Close patient monitoring during transition to cyclic PN is essential**
- Key parameters include:
  - Insulin dosing regimens must be tailored to avoid abnormal blood glucose fluctuations.
  - Key considerations include:
    - Subcutaneous correctional insulin given in the final phase of the cycle could lead to hypoglycemia when PN is discontinued
    - Patients receiving large insulin doses in PN formulations may require intermediate or long-acting insulin to prevent hyperglycemia after PN stops
    - Abrupt infusion initiation may cause hyperglycemia and requires monitoring

Cyclic Considerations

Cyclic PN should be considered for patients with or at risk of liver dysfunction, those on long-term PN, and stable, active patients who may benefit from infusion-free time periods.

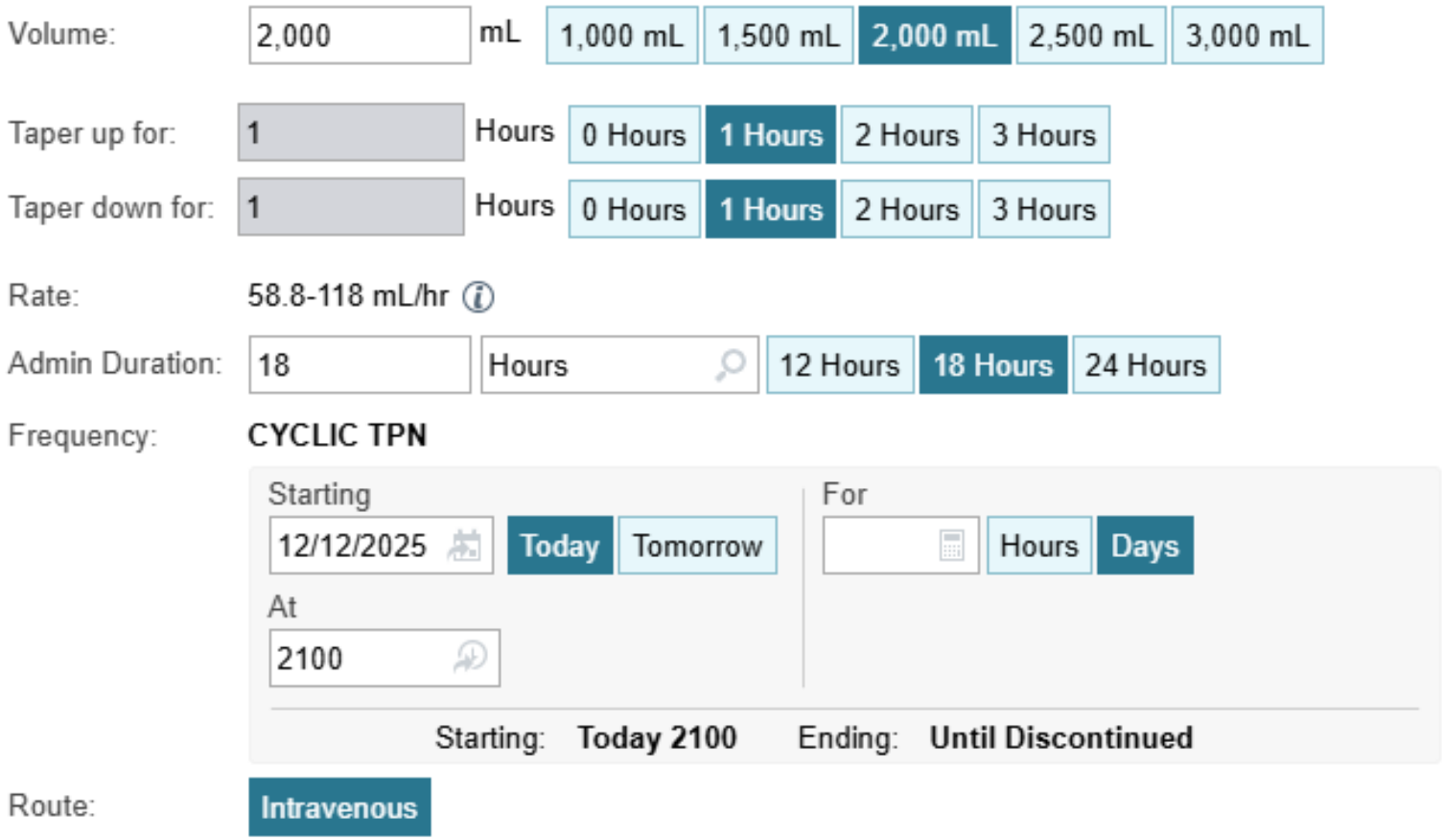
Cyclic PN Titration Strategy

Gradually shorten infusion duration by **4-hour increments each day**, targeting a minimum **12-hour cycle**:

- Day 1: 20-hour infusion
- Day 2: 16-hour infusion
- Day 3: 12-hour infusion

Administer at **50% of the target rate** during the **first and last hour** of the cycle to minimize risks of **hyperglycemia and rebound hypoglycemia**.

Cyclic Considerations



Special Populations

Special Population Management

Condition	Recommendations
Renal Insufficiency	• CRRT has been shown to decrease selenium. Provide additional selenium up to 275 mcg/day to supplement effluent loss • Dialysate solutions with potassium and magnesium preferred over IV electrolyte replacement. Check to see what solutions are currently standard. Review dialysis orders to determine appropriate electrolyte amount per dialysis schedule
Azotemia (BUN >100)	• Ensure appropriate hydration • Reduce amino acids in PN • Consult with registered dietitian and/or nephrologist on amount of amino acid to adjust
Hepatic Steatosis • Causes: Excess energy intake, GIR > 4-5 mg/kg/min	• Avoid overfeeding • Decrease TPN dextrose content
Pancreatitis	• Monitor blood glucose daily • Monitor triglycerides twice weekly • If hypertriglyceridemia, adjust lipid infusion (see hypertriglyceridemia section)

Hypertriglyceridemia
• Rate of IVFE exceeds capacity of plasma fat clearance
	• TG > 200 mg/dL
	  • Reduce lipid dose to minimum amount required to prevent EFAD
	  • Monitor TG more frequently
	• TG > 400 mg/dL
	  • Hold lipids

Special Population Management

Condition	Recommendations
Bariatric surgery	• Obese patients should receive thiamine prior to PN Initiation
Burn Patients	• Increased copper, selenium, and zinc doses
Patients with extreme insulin resistance	• Chromium 20-40mcg daily added to TPN can improve glycemic control

Adding Vitamin C	• Indications for addition:
	  • Pressure injuries: add ascorbic acid 500-1000 mg/day
	  • Renal insufficiency not on dialysis: add ascorbic acid 500 mg/day
	• Contraindications: Hx of or at risk for nephrolithiasis

High intestinal fistula or ileostomy output	• Additional elemental zinc up to 12 mg / day
Major trauma or cardiac surgery	• Additional selenium up to 275 mcg/day

Overcoming Shortages

Overcoming Shortages

Evaluate clinical appropriateness before initiating PN.

- Prioritize TPN/PN support for neonates, severely malnourished patients, and patients without functional or accessible GI tracts, or those at high risk for morbidity without parenteral nutrition.

Optimize resource conservation.

- When clinically appropriate, utilize partial PN or reduced-volume formulations, defer non-urgent PN, and transition to enteral nutrition (EN) as soon as tolerable.

Preserve compounding resources and ensure safety.

- Maintain strict aseptic technique and compounding standards to reduce product waste, prevent incompatibilities, and minimize infusion-related complications.
- Example: individually compound ILE (intralipid) doses for pediatric and neonatal patients.

Overcoming Shortages

Consider product alternatives when appropriate.

- Use premixed TPN formulations when feasible to reduce compounding burden and conserve raw components.

Maximize available enteral options.

- Provide oral or enteral supplementation (tablet or liquid formulations) for patients who can safely tolerate GI intake.
- Note: This strategy is not appropriate for patients with malabsorption syndromes or a nonfunctional gastrointestinal tract.

Shortages and Overcoming Strategies

PN ingredient	

Amino acid	• **Alternative amino acid products** may differ in pH and cause acid-base abnormalities.
	• **Inherent electrolytes** (e.g., sodium, phosphate, acetate, chloride) or buffering ingredients vary between products.
	• **Calcium-phosphate compatibility curves** are not interchangeable across amino acid formulations.
	• **Fluid accumulation** risk due to inability to use concentrated products.
	• Consider **adjusting amino acid dosing** for select patient populations:
	  • Patients without significant protein loss (e.g., low intestinal output, not on CRRT) → target lower protein goals.
	  • Long-term TPN patients → consider temporarily reducing protein goals.
	• **Adjust other macronutrients** as needed to compensate for decreased caloric intake.
	• **Prioritize amino acid allocation** for patients with: High intestinal output, Severe burns, Traumatic injuries, Patients on CRRT, Severe malnutrition
	• **Consider supplemental enteral or oral amino acids** for patients who can tolerate them.

Shortages and Overcoming Strategies

PN ingredient	

Intralipid emulsion	• Maintain guidelines recommendation for high-risk patient population. This includes, but not limited to severely malnutrition patients, high risk for refeeding syndrome, pregnancy)
	• **Identify patients at low risk for essential fatty acid deficiency (EFAD) (**PN use for < 2 weeks)
	• **Intravenous lipid emulsion (ILE) conservation:**
	  • Reduce ILE in adults; aim for ~100 g weekly to prevent EFAD.
	  • Prioritize ILE for neonatal and pediatric patients.
	  • Adjust Non-protein calories:
	  • Consider increasing dextrose to compensate for reduced ILE in selected patients.
	  • Monitor closely for hyperglycemia and adjust GIR accordingly.
	  • **For Critical care patients-** Patients receiving propofol or clevidipine may not require additional ILE.
	  • **Monitor for signs of EFAD:** Diffuse dry, scaly rash, Alopecia, Thrombocytopenia, etc…

Sodium or potassium chloride	• Use alternative sodium chloride products • Shortages may lead to fluid overload when switching to less concentrated solutions (e.g., using 3% or 0.9% sodium chloride due to a 23.4% sodium chloride shortage) • Patients with significant chloride losses (e.g., from gastric losses) may develop metabolic alkalosis if chloride-containing salts are unavailable • Consider oral/enteral supplements (tabs or fluids) for patients who may tolerate oral/enteral options
Sodium or potassium acetate	• Metabolic acidosis in patients with high acetate needs and no acetate salts

Overcoming Shortages

PN ingredient	

Intralipid emulsion	• Maintain guidelines recommendation for high-risk patient population. This includes, but not limited to severely malnutrition patients, high risk for refeeding syndrome, pregnancy)
	• **Identify patients at low risk for essential fatty acid deficiency (EFAD) (**PN use for < 2 weeks)
	• **Intravenous lipid emulsion (ILE) conservation:**
	  • Reduce ILE in adults; aim for ~100 g weekly to prevent EFAD.
	  • Prioritize ILE for neonatal and pediatric patients.
	  • Adjust Non-protein calories:
	  • Consider increasing dextrose to compensate for reduced ILE in selected patients.
	  • Monitor closely for hyperglycemia and adjust GIR accordingly.
	  • **For Critical care patients-** Patients receiving propofol or clevidipine may not require additional ILE.
	  • **Monitor for signs of EFAD:** Diffuse dry, scaly rash, Alopecia, Thrombocytopenia, etc…

Sodium	• Utilize **alternative** sodium chloride formulations when shortages occur. • Transitioning to less concentrated products (e.g., 3% or 0.9% sodium chloride during a 23.4% shortage) may increase the risk of fluid overload. • Consider oral or enteral chloride supplementation (tablets or solutions) for patients who can tolerate enteral administration. • Reassess the underlying cause of hyponatremia; adjustments such as reducing dextrose concentration or decreasing the parenteral nutrition infusion rate may be required. • Monitor for signs and symptoms of hyponatremia

Overcoming Shortages

PN ingredient		
Potassium	•	Consider administering potassium Premix bags externally to TPN
Chloride	•	Patients experiencing substantial chloride losses (such as from gastric output) may be at risk for metabolic alkalosis if chloride-containing salts are limited or unavailable.
Acetate	•	Patients with elevated acetate requirements may develop metabolic acidosis if acetate salt products are limited
Phosphate	•	Prioritize IV phosphate use for high-risk populations (e.g., symptomatic hypophosphatemia, pediatric, and neonatal patients)
Calcium Gluconate	•	Consider administering calcium gluconate or chloride Premix bags externally to TPN; • 1 g $CaCl_2$ provides ~13.6 mEq vs. 1 g calcium gluconate ~4.65 mEq.
Magnesium	•	Consider administering magnesium Premix bags externally to TPN
Multi-vitamins and Multi-trace	•	Consider utilizing induvial components - thiamine, ascorbic acid, pyridoxine, and folic acid

Multivitamin Components (based on Infuvite per 10 mL)

Component	Amount	Component	Amount
Ascorbic acid	200 mg	Dexpanthenol	15 mg
Vitamin A	3000 IU	Vitamin E	10 IU
Vitamin D_3 (cholecalciferol)	200 IU	Vitamin K	150 mcg
Thiamine (Vit B_1)	6 mg	Folic acid	600 mcg
Riboflavin (Vit B_2)	3.6 mg	Biotin	60 mcg
Pyridoxine	6 mg	Cyanocaobalamine (Vit B_{12})	5 mcg
Niacinamide	40 mg		

* Daily requirements for adult parenteral vitamins (ASPEN) are fulfilled by Infuvite

American Society for Parenteral and Enteral Nutrition (ASPEN). Appropriate dosing for parenteral nutrition: ASPEN recommendations. November 2020. Available at: https://www.nutritioncare.org/ProductShortageManagement/. Accessed November 25, 2025

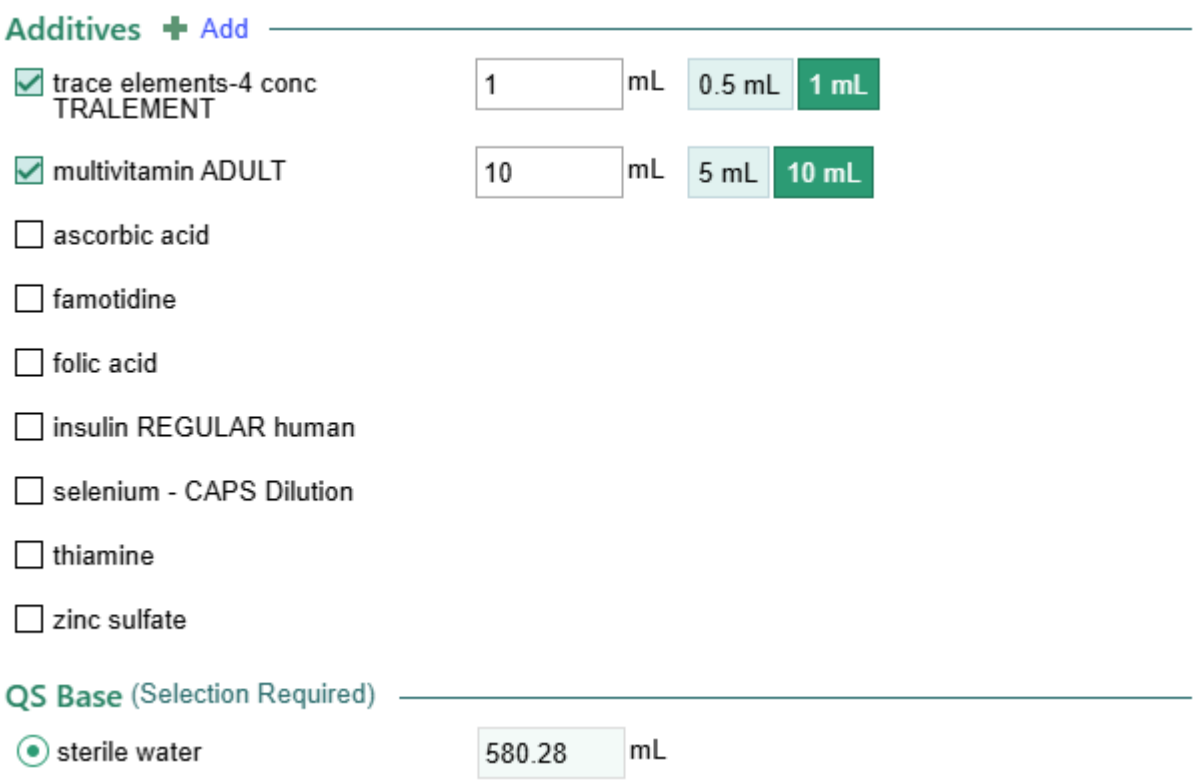
Other Parenteral Nutrition Additives

Trace Element	Standard Daily Requirement
Chromium	<1 mg
Copper	0.3 - 0.5 mg
Manganese	55 mcg
Selenium	60 – 100 mcg
Zinc	3 - 5 mg

Additive	Common Doses
Ascorbic Acid	500 - 1000 mg
Famotidine	20 - 40 mg
Folic acid	0.4 – 1 mg
Insulin REGULAR human	See glycemic control section
Selenium	20 - 60 mcg
thiamine	100 mg
Zinc sulfate	5 -10 mg

American Society for Parenteral and Enteral Nutrition (ASPEN). Appropriate dosing for parenteral nutrition: ASPEN recommendations. November 2020. Available at: https://www.nutritioncare.org/ProductShortageManagement/. Accessed November 25, 2025

Additives


Additives
Add
trace elements-4 conc TRALEMENT
1
mL
0.5 mL
1 mL
multivitamin ADULT
10
mL
5 mL
10 mL
ascorbic acid
famotidine
folic acid
insulin REGULAR human
selenium - CAPS Dilution
thiamine
zinc sulfate
QS Base (Selection Required)
sterile water
580.28
mL

Thank You

Sutter Health

New System Parenteral Nutrition Policy and Protocol

New system policy outlines pharmacy responsibilities in the provision and management of parenteral nutrition (PN) for adult patients

Q1 2025

- Identified pharmacist throughout Sutter for taskforce

Q2 2025

- Reviewed latest guidelines, research data and practice for updated policy and protocol
- Elicit multidisciplinary team for feedback

Q3 2025

- System P&T Approval August 2025
- Local site P&T approval

Q4 and On-going

- Epic Willow Build
- Pending EPOC approval
- Pending Education and Competency

Implicit Bias Strategies

- Disparities affect outcomes in underserved communities
- Tailor clinical conversations with cultural humility.
- Avoid assumptions, slow down to ensure understanding, and build trust.
- Understand Social Drivers of Health.
- Remember to listen actively, ask respectfully, and speak inclusively.
- Refer to Sutter Health Workday for additional information:
  - JOB5946 Building a Bridge to Equitable Care
  - JOB1108 Unconscious Bias: The 3Rs, Recognize, Review and Replace
  - REG1997 Understanding the Importance of Cultural Competence, Diversity, and Inclusion

Sutter JOB5946 Building a Bridge to Equitable Care:
https://www.myworkday.com/sutterhealth/learning/course/eb915d5a65071002024d12cca5180001?type=9882927d138b100019b928e75843018d&record=7bfcabbc46321001162aba457e5b0000

Additional References

1. Monczka, Jessica et al. Parenteral Nutrition Order Review: Skills and Competencies Required for Success. Pharmacy Practice News. May 28, 2025.

2. Shan, Haili et al. Optimizing parenteral nutrition practices: Impact of a pharmacist-led quality improvement program on prescription patterns and work efficiency. Nutrition. Volume 140, December 2025, 112888.

3. Kwan, Noelle. Pharmacists' Role in Expanding Healthcare Equity. *US Pharm*. 2024;49(8):41-45.

4. Gopal, Dipesh et al. Implicit bias in healthcare: clinical practice, research and decision making. Future Healthcare J. 2021 Mar;8(1):40–48.