Total Parenteral Nutrition (TPN)

A Comprehensive Clinical Guide

Evidence-Based Practices for Adult Patients
Including Surgical, Critical Care, and Oncology Settings

Learning Objectives

By the end of this presentation, you will be able to:

1. **Identify** appropriate indications and contraindications for TPN
2. **Assess** nutritional status and determine when to initiate TPN
3. **Calculate** nutritional requirements and prescribe appropriate TPN formulations
4. **Monitor** patients on TPN and recognize complications
5. **Manage** metabolic complications and catheter-related issues
6. **Transition** patients from parenteral to enteral nutrition safely
7. **Apply** special considerations for different patient populations

What is Total Parenteral Nutrition?

Definition: TPN is the delivery of all essential nutrients intravenously, bypassing the gastrointestinal tract entirely.

Components of TPN:

- **Macronutrients:** Carbohydrates (dextrose), proteins (amino acids), fats (lipid emulsions)
- **Micronutrients:** Electrolytes, vitamins, minerals, trace elements
- **Fluids:** Water for hydration and as a vehicle for nutrients

Delivery Methods:

Central PN (CPN)

- High osmotic load (>900 mOsm/L)
- Delivered via central venous catheter
- Standard for long-term use

Peripheral PN (PPN)

- Lower osmotic load (<900 mOsm/L)
- Delivered via peripheral IV
- Limited to short-term use

Fundamental Principle of Nutrition Support

> 🎯 **"If the gut works, use it!"**

Why Enteral Nutrition is Preferred:

- Maintains intestinal barrier function
- Reduces risk of bacterial translocation
- Lower infection rates compared to TPN
- More physiologic nutrient delivery
- Less expensive and easier to manage
- Avoids central line complications

Remember: TPN should only be used when enteral nutrition is contraindicated, insufficient, or impossible.

Indications for TPN

Primary Indications:

1. **Gastrointestinal Failure**
   - Bowel obstruction (mechanical or malignant)
   - Severe malabsorption
   - Short bowel syndrome
   - Severe inflammatory bowel disease
2. **Post-Surgical Complications**
   - Anastomotic leak with peritonitis
   - High-output enterocutaneous fistula (>500 mL/day)
   - Prolonged postoperative ileus
   - Chyle leak unresponsive to dietary modification
3. **Cancer-Related**
   - Malignant bowel obstruction with reasonable prognosis (>2-3 months)
   - Severe mucositis from chemotherapy/radiation
   - Preoperative optimization in malnourished patients

Key Criterion: Expected inadequate oral/enteral intake for ≥7-14 days in well-nourished patients, or ≥5 days in malnourished patients.

Contraindications to TPN

Absolute Contraindications:

- ❌ Functional GI tract where enteral nutrition is possible
- ❌ Expected duration of fasting <5 days
- ❌ Terminal illness with life expectancy <1 month
- ❌ Patient refusal or advance directive against artificial feeding

Relative Contraindications (Require Careful Management):

- Hemodynamic instability/shock
- Severe hyperglycemia (>200 mg/dL)
- Severe electrolyte disturbances
- Active bacteremia/fungemia
- Severe hypertriglyceridemia (>1000 mg/dL)
- Severe liver dysfunction
- Volume overload
- Lack of appropriate venous access

Critical: Always stabilize these conditions before initiating TPN, or adjust TPN prescription accordingly.

Preoperative Nutritional Assessment

Screening Tools:

- Nutritional Risk Screening 2002 (NRS-2002)
- Subjective Global Assessment (SGA)
- Nutrition Risk Index
- Perioperative Nutrition Score

Indicators of Malnutrition:

Parameter	Significant Finding
Weight Loss	>10% over 6 months or >5% over 3 months
BMI	<18.5 kg/m²
Albumin	<3.0 g/dL (with clinical signs)
Oral Intake	<50% of requirements for >1 week
Muscle Mass	Visible wasting or reduced function

Note: Albumin and prealbumin are negative acute phase reactants and may not accurately reflect nutritional status in acute illness.

When to Start TPN: Evidence-Based Timing

Patient Categories and Timing:

Patient Category	Timing of TPN Initiation	Rationale
Well-nourished, non-critical	After 7-14 days NPO	Can tolerate brief fasting periods
Malnourished	Within 24-48 hours if EN not possible	High risk for complications
Critically ill	After 7 days if EN insufficient	Early PN may increase complications
Preoperative	7-14 days before surgery if malnourished	Reduces postoperative complications

Evidence: Early parenteral nutrition in well-nourished patients does not improve outcomes and may increase infection risk.

Calculating Nutritional Requirements

Energy Requirements:

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Standard Patient: 25 kcal/kg/day
Stress/Wounds: 30-35 kcal/kg/day
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Macronutrient Distribution:

Component	Standard Dose	% of Calories	Energy Value
Protein	1.2-2.0 g/kg/day	15-20%	4 kcal/g
Dextrose	3-5 g/kg/day	50-60%	3.4 kcal/g
Lipids	0.5-1.0 g/kg/day	20-30%	10 kcal/g (20% emulsion)

Special Populations:

- **Burns/Major trauma:** Protein 1.5-2.5 g/kg/day
- **Obesity (BMI >30):** Use adjusted body weight
- **Renal failure:** Consider protein restriction if not on dialysis
- **Liver failure:** Use dry weight for calculations

TPN Formulation Types

2-in-1 Formulation

- Dextrose + amino acids mixed
- Lipids infused separately
- Clear solution
- Easier to inspect for precipitation

3-in-1 (TNA) Formulation

- All components mixed together
- Opaque white solution
- More convenient administration
- Minimum 2% lipid concentration required

Electrolyte Requirements:

Electrolyte	Daily Requirement
Sodium	1-2 mEq/kg/day
Potassium	1-2 mEq/kg/day
Magnesium	8-20 mEq/day
Calcium	10-15 mEq/day
Phosphorus	20-40 mmol/day

Plus daily multivitamins and trace elements

Vascular Access for TPN

Central Access Options:

Access Type	Duration of Use	Advantages	Disadvantages
PICC Line	Days to months	Easy insertion, lower infection risk	Thrombosis risk, requires arm mobility
Tunneled CVC	Months to years	Long-term use, lower infection rates	Surgical placement required
Non-tunneled CVC	<30 days	Quick placement, readily available	Higher infection risk
Implanted Port	Years	Low infection risk, cosmetic	Surgical placement, needle access

Best Practice: Use a dedicated single-lumen catheter for TPN when possible. If multi-lumen, dedicate one port exclusively for TPN.

TPN Initiation Protocol

Day 1: Start at 50% of Goal

Rationale: Reduces risk of refeeding syndrome and allows metabolic adaptation

Pre-initiation Checklist:

- ✓ Confirm central line placement (X-ray verification)
- ✓ Obtain baseline labs (BMP, Mg, Phos, LFTs, triglycerides)
- ✓ Correct severe electrolyte abnormalities
- ✓ Give thiamine 100 mg IV if at risk for deficiency
- ✓ Calculate requirements and write initial order

Day 2-3: Advance to Goal

- If glucose controlled (<180 mg/dL)
- If electrolytes stable
- If no signs of refeeding syndrome
- Advance to 100% of calculated needs

Tip: Start conservatively – it's easier to increase TPN than to manage complications from overfeeding.

Monitoring Patients on TPN

Laboratory Monitoring Schedule:

Test	Initial (Days 1-3)	Stable Patient	Long-term
Basic Metabolic Panel	Daily	2-3x/week	Weekly
Magnesium, Phosphate	Daily	2-3x/week	Weekly
Glucose	q6h fingersticks	Daily	As needed
Liver Function Tests	Baseline	Weekly	Monthly
Triglycerides	Day 2-3	Weekly	Monthly
Trace Elements	Not needed	Not needed	Every 3 months

Clinical Monitoring:

- Daily weights and I/O
- Temperature and vital signs
- Central line site inspection
- Signs of fluid overload

Refeeding Syndrome: Recognition & Prevention

High-Risk Patients:

- BMI <16 kg/m²
- Unintentional weight loss >15% in 3-6 months
- Little or no intake for >10 days
- Low baseline K, Phos, or Mg
- Chronic alcoholism or malabsorption

Hallmark Features:

- **Hypophosphatemia** (most common)
- Hypokalemia
- Hypomagnesemia
- Fluid retention/edema
- Cardiac dysfunction
- Respiratory failure

Prevention Protocol:

1. **Give thiamine 100-300 mg IV** before feeding
2. Start at 10-20 kcal/kg/day (max 50% of goal)
3. Monitor electrolytes every 6-12 hours initially
4. Aggressively replete electrolytes
5. Advance slowly over 3-5 days

Managing Metabolic Complications

Hyperglycemia

- Target: 140-180 mg/dL
- Add insulin to TPN bag
- Use sliding scale insulin
- Consider reducing dextrose

Hypertriglyceridemia

- Hold lipids if >400 mg/dL
- Contraindicated if >1000 mg/dL
- Reduce frequency (2-3x/week)
- Account for propofol lipids

Liver Dysfunction

- Avoid overfeeding
- Cycle TPN (12-18 hours/day)
- Consider mixed lipid emulsions
- Provide some enteral intake

Electrolyte Imbalances

- Daily adjustment initially
- Account for losses (drains, fistulas)
- Use appropriate salts (Cl vs acetate)
- Monitor acid-base status

Catheter-Related Complications

Catheter-Related Bloodstream Infection (CRBSI)

Incidence: 6-21% in cancer patients with bowel obstruction

Prevention Strategies:

- Strict aseptic technique for all line handling
- Dedicated TPN lumen (no other uses)
- Chlorhexidine hub cleaning
- Consider ethanol/antibiotic locks for long-term use
- Daily site inspection

Management of Suspected CRBSI:

1. Draw blood cultures (central and peripheral)
2. Start empiric antibiotics if septic
3. Consider line removal if persistent bacteremia
4. May need "line holiday" before replacement

Other Catheter Complications:

- **Thrombosis:** Swelling, inability to draw blood → ultrasound, anticoagulation
- **Occlusion:** Fibrin sheath → alteplase dwell
- **Mechanical:** Malposition, fracture → imaging, replacement

TPN in Gynecologic Oncology

Common Indications:

- **Malignant bowel obstruction** - Most frequent indication
- Preoperative optimization before debulking surgery
- Post-exenteration or extensive resection
- Severe chemoradiation toxicity

Decision Framework for Malignant Bowel Obstruction:

Consider TPN if:	Avoid TPN if:
Life expectancy >2-3 months Good performance status Further cancer therapy planned Potentially reversible obstruction	Life expectancy <1 month Poor performance status No further treatment options Patient preference for comfort care

Evidence: Median survival with TPN in ovarian cancer MBO: 72 days vs 41 days without (when adjusted for chemotherapy, difference not significant)

TPN in Critical Illness

Key Differences in ICU Patients:

- Higher metabolic demands (stress response)
- Increased risk of hyperglycemia
- Fluid balance considerations
- Multiple organ dysfunction

Timing in Critical Illness:

Important: Delay TPN for 7 days in well-nourished critically ill patients who cannot receive adequate EN

Evidence from EPaNIC Trial:

- Early PN (within 48h) vs Late PN (after day 7)
- Late PN showed:
  - Fewer infections
  - Shorter ICU stay
  - Lower healthcare costs

Exceptions - Consider Earlier TPN:

- Pre-existing severe malnutrition
- Inability to advance EN after multiple attempts
- High-output losses not meeting needs

Weaning and Discontinuing TPN

When to Start Weaning:

- GI function returning (bowel sounds, passing gas/stool)
- Obstruction resolving
- Tolerating oral/enteral intake
- Meeting >60% of needs enterally

Weaning Protocol:

1. **Assess enteral tolerance:** Start clear liquids, advance as tolerated
2. **Calculate intake:** Track calories from oral/enteral sources
3. **Proportional reduction:** Decrease TPN as enteral increases
4. **Consider cycling:** Run TPN 12-18 hours (usually overnight)
5. **Final taper:** Reduce rate by 50% for last 1-2 hours

Goal: Discontinue TPN when patient reliably meeting >60-75% of nutritional needs enterally for 2-3 days

Monitor: Check blood glucose 30-60 minutes after stopping TPN to rule out rebound hypoglycemia

TPN in Palliative & End-of-Life Care

Ethical Framework:

TPN is a medical intervention, not basic care. Decision should align with patient's goals and prognosis.

Generally NOT Indicated:

- Terminal cancer with life expectancy <1 month
- Refractory cachexia
- No further cancer-directed therapy
- Poor performance status (bedridden)

May Be Considered:

- Life expectancy >2-3 months
- Ongoing cancer treatment with potential benefit
- Reversible obstruction
- Patient/family understanding of goals

Communication Points:

- Loss of appetite is part of the dying process
- TPN will not reverse advanced cancer
- May increase burden (infections, fluid overload)
- Focus on comfort measures and quality time

Key Message:

Involve palliative care team early for goals-of-care discussions

TPN Prescription Example

Case: 70 kg patient, post-operative bowel resection

Step 1: Calculate Requirements

- Calories: 25 kcal/kg = 1750 kcal/day
- Protein: 1.5 g/kg = 105 g/day
- Volume: 35 mL/kg = 2450 mL/day

Step 2: Macronutrient Distribution

Component	Amount	Calories
Protein (amino acids)	105 g	420 kcal (24%)
Dextrose	275 g	935 kcal (53%)
Lipids (20% emulsion)	200 mL	400 kcal (23%)
Total	2400 mL	1755 kcal

Step 3: Add Electrolytes & Micronutrients

- Standard electrolyte package
- MVI (multivitamin) daily
- Trace elements daily

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Day 1: Run at 50 mL/hr (50% of goal)
Day 2: If stable, advance to 100 mL/hr
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TPN Best Practices: Key Takeaways

🎯 Use TPN Only When Indicated

- Always prefer enteral nutrition when possible
- Reserve for true GI failure or contraindications to EN
- Avoid in terminal patients with short prognosis

📊 Monitor Vigilantly

- Daily labs initially, then taper frequency
- Watch for refeeding syndrome in first 72 hours
- Track glucose, triglycerides, liver function

🛡️ Prevent Complications

- Start at 50% of goal to prevent refeeding
- Strict aseptic technique for line care
- Avoid overfeeding

🤝 Use Team-Based Care

- Involve nutrition support team
- Coordinate with pharmacy
- Communicate with palliative care when appropriate

Common Pitfalls to Avoid

❌ Pitfall #1: Starting TPN Too Early

Well-nourished patients can tolerate 7-14 days without nutrition. Early TPN increases infection risk without benefit.

❌ Pitfall #2: Ignoring Refeeding Risk

Failing to recognize high-risk patients and not giving thiamine or starting slowly can be fatal.

❌ Pitfall #3: Overfeeding

More is not better! Overfeeding causes hyperglycemia, liver dysfunction, and increased CO2 production.

❌ Pitfall #4: Not Attempting Enteral Nutrition

Always trial EN first, even small amounts. Trophic feeds maintain gut integrity.

❌ Pitfall #5: Continuing TPN Without Clear Goals

Regularly reassess: Is TPN meeting its objectives? Is transition to EN possible?

Quick Reference Guide

TPN Checklist:

☐ Before Starting:

- Confirm EN contraindicated/insufficient
- Central access verified
- Baseline labs obtained
- Thiamine given if at risk
- Calculate requirements

☐ Daily Monitoring:

- BMP, Mg, Phos (initially)
- Glucose checks
- I/Os and weight
- Line site inspection
- Assess for EN readiness

☐ Weekly Monitoring:

- LFTs
- Triglycerides
- Reassess goals
- Adjust prescription

☐ Red Flags Requiring Action:

- Phos <2.0 mg/dL → Hold TPN, replete
- Triglycerides >400 mg/dL → Reduce lipids
- Glucose >200 mg/dL → Add insulin
- New fever → Culture, consider CRBSI

Summary: Key Messages

Remember the Fundamentals:

1️⃣ **TPN is a last resort** - Use only when enteral nutrition is impossible or insufficient

2️⃣ **Timing matters** - Don't start too early in well-nourished patients

3️⃣ **Start conservatively** - Begin at 50% of goal to prevent complications

4️⃣ **Monitor closely** - Prevent and detect complications early

5️⃣ **Transition when possible** - Always work toward enteral nutrition

Optimal TPN management requires knowledge, vigilance, and multidisciplinary collaboration