NUTRITION OF THE SURGICAL PATIENT & METABOLIC RESPONSE TO INJURY

Wednesday , Nov 28 2007 , Dr. Omar Al-Farouk

Hi !! These are some guiding signs :

(!) : Important note .

☒ : The Dr didn't mention this at all but it was found in the slides .

✡ : Is a risk question --> The Dr said that this point was important or asked a question about it .

- Have Q's ? found errors ? send them at : surgeryqueens@gmail.com

- Have fun studying ,, or .. at least اخلصوا النية لله.

MALNUTRITION

- In surgical practice malnutrition is common.
- It is present before or occurring after operation in about 50% of patients.

PREOPERATIVE MALNUTRITION:

1- Starvation:

- Difficulty in obtaining food **(poverty).**
- Difficulty in swallowing food **(dysphagia).**
- Difficulty in retaining swallowed food **(vomiting).**

2- Failure of proper digestion:

- Pancreatic or biliary disease.
- Duodenal & jejunal conditions ***e.g. fistula***.

(!) GIT total secretions are up to 8 liters / day of protein rich enzyme & fluids , so a patient with a fistula is not nourished.

POSTOPERATIVE MALNUTRITION:

- Mostly of transient nature consequent upon a short period of starvation & the stress reaction to trauma.
- Recovery of nitrogen deficit will follow on the return of normal feeding.

HYPERCATABOLIC STATES:

- Severe sepsis.
- Severe trauma as in burns.
- Severe inflammation as in pancreatitis.

(!) The most severe forms of malnutrition are the hyper catabolic states.

Disease process	*kcal/day*
Basal	1,450
Postop (uncomplicated)	1,500–1,700
Sepsis	2,000–2,400
Multiple trauma (ventilator)	2,200–2,600
Major burn	2,500–3,000

Caloric Requirements For The Average Adult (70 kg) male

	starvation	Severe injury
Basal metabolic rate	—	++
Presence of mediators	—	+++
Major fuel oxidized	Fat	Mixed
Ketone body production	+++	±
Hepatic ureagenesis	+	+++
(-ve) nitrogen balance	+	+++
Gluconeogenesis	+	+++
Muscle proteolysis	+	+++
Hepatic protein synthesis	+	+++

Metabolic Differences Between The Response To Simple Starvation & Injury

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CHANGES AFTER INJURY & SURGERY:

- There is an increased oxygen & calorie consumption & a negative nitrogen balance.
- The increase in the resting metabolic expenditure:
  - minimal after uncomplicated surgery .
  - 30% with multiple fractures.
  - 45% in peritonitis .
  - 100% in burns.
- An increase in metabolic rate & protein catabolism of >25% is regarded as a hyper catabolic state.
- Glycogen breakdown accelerated principally by adrenaline & glucagon.
- Cortisol & glucagon induces gluconeogenesis from amino acids .
- Lipolysis is increased by growth hormone, glucagon & noradrenaline.

EFFECTS OF MALNUTRITION:

- Poor wound healing & wound dehiscence. (***no proteins = no wound healing)***
- Leaking anastomosis of bowel.***(impaired healing of the anastomosis after surgery = leaking)***
- Disordered coagulation.***(malnutrition caused by obstructive jaundice impairs the absorption of fat soluble vitamins e.g. Vitamin K , so they are more prone to bleeding & disordered coagulation)***
- Reduced enzyme synthesis.
- Impaired oxidative metabolism by the liver.
- Immunological depression .
- Decreased tolerance to radiotherapy & chemotherapy.

INDICATIONS FOR NUTRITIONAL SUPPORT:

1) Preoperative nutritional depletion.
2) Postoperative complications.
   - Ileus more than 4 days
   - Sepsis
3) Intestinal fistula.
4) Massive bowel resection.
5) Management of:
   - Pancreatitis.
   - Malabsorption syndromes.
   - Ulcerative colitis.
   - Radiation enteritis.
   - Pyloric stenosis.
6) Intractable vomiting.
7) Maxillofacial trauma.
8) Multiple trauma & burns.
9) Malignancy.

Nutritional Support:

May supplement normal feeding, or completely replace normal feeding into the gastrointestinal tract.

- **Who requires nutritional support?**
  - Patients already with malnutrition/ surgery/trauma/sepsis.
  - Patients at risk of malnutrition.

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Patients at risk of malnutrition:

- Depleted reserves.
- Cannot eat for > 5 days.
- Impaired bowel function. ***(ulcerative colitis , pancreatitis , Crohn's disease)***
- Critical Illness.
- Need for prolonged bowel rest.

How do we detect malnutrition?

Nutritional Assessment:

- History .
- Physical examination.
- Anthropometric measurements.
- Laboratory investigations.

History :

- Dietary history
- Significant weight loss within last 6 months.
  - 15% loss of body weight compare with ideal weight.
- Beware the patient with ascites/edema.

Physical Examination :

- Evidence of muscle wasting.
- Depletion of subcutaneous fat.
- Peripheral edema, ascites.
- Features of Vitamin deficiency.
  - E.g. nail & mucosal changes (echymosis & easy bruising).

Anthropometry :

- Weight for Height comparison:
  - Body Mass Index (<19, or >10% decrease).
- Triceps-skin fold :
  - the minimum is 13mm in females & 10mm in males .
- Mid arm muscle circumference:
  - <23cm in females.
  - <25cm in males .
- H& grip dynamometry.

Lab investigations:

- albumin <30 mg/dl.
- pre-albumin <12 mg/dl.
- transferrin <150 mmol/l.
  - ➔ these are proteins = indicate proteins loss.
- total lymphocyte count < 1800 / $mm^{3.}$ ***(= immunologically incompetent)***
- tests reflecting specific nutritional deficits .
  - e.g. Prothrombin time. ***(indicates: vitamin deficiency)***
  - Skin anergy testing

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Types of Nutritional Support:

- Enteral Nutrition ***(through GI tract)***
- Parenteral Nutrition ***(through I.V.)***

(!) Enteral Feeding is best:

- More physiologic
- Less complications
- Gut mucosa preserved
- No bacterial contamination.
- Cheaper.

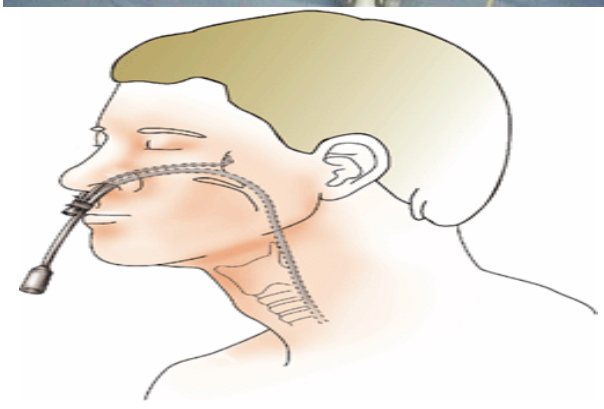
Enteral Feeding is indicated:

- When nutritional support is needed.
  - Functioning gut present.
- No contra-indications.
  - **(!)** no ileus, no recent anastomosis, no fistula.

(✡) Types of feeding tubes:

- *Tubes inserted down the upper GIT, following normal anatomy*
  - Naso-gastric tubes ***(most type used , but only for a short period b/c has a lot of complications-so it's the best for short periods)***
  - Oro-gastric tubes
  - Naso-duodenal tubes
  - Naso-jejunal tubes
- Tubes that require an invasive procedure for insertion
  - Gastrostomy tubes
  - Jejonostomy tubes
    - ➔ ***Both for prolonged feeding.***
- **What can we give in tube feeding?**
  - Blenderised feeds.
  - Commercially prepared feeds :

  e.g. Isocal, Ensure, Jevity , Vivonex.



Complications of enteral feeding:

{ 12% overall complication rate }

I) Gastrointestinal complications.
II) Mechanical complications.
III) Metabolic complications.
IV) Infectious complications.

- **Gastrointestinal:**
  - Distension.
  - Nausea & vomiting .
  - Diarrhea ***(most common).***
  - Constipation.

- **Infectious:**
  - Aspiration Pneumonia ***(naso-gastric tube).***
  - Bacterial contamination ***(food poisoning).***

- **Mechanical:**
  - Mal-position of feeding tube.
  - Sinusitis ***(naso-gastric tube).***
  - Ulcerations / erosions.
  - Blockage of tubes.

(!) Causes of Diarrhea in Tube-Fed Patients

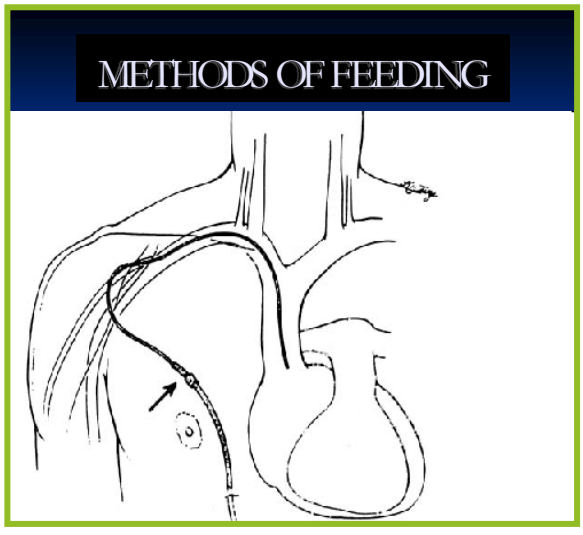
COMMON CAUSES UNRELATED TO TUBE FEEDING
1. Elixir medications containing sorbitol
2. Magnesium-containing antacids
3. Antibiotic-induced sterile gut
4. Pseudomembranous colitis

POSSIBLE CAUSES RELATED TO TUBE FEEDING
1. Inadequate fiber to form stool bulk
2. High fat content of formula (in presence of fat malabsorption syndrome)
3. Bacterial contamination of enteral products & delivery systems (causal association with diarrhea not documented).
4. Rapid advancement of rate (after GI tract is unused for prolonged periods).

UNLIKELY CAUSES RELATED TO TUBE FEEDING
1. Formula hypersomolality (proved not to be a cause of diarrhea)
2. Lactose (absent from nearly all enteral feeding formulas)

Parenteral Nutrition:
- Allows greater caloric intake BUT :
  - Is more expensive.
  - Has more complications.
  - Needs more technical expertise.

Who will benefit from parenteral nutrition?
- Patients with/who :
  - Abnormal Gut function.
  - Cannot consume adequate amounts of nutrients by enteral feeding.
  - Are anticipated not to be able to eat for 5 days.
  - Prognosis warrants aggressive nutritional support.



Abnormal GIT Function :
- Short bowel syndrome ***(resection of bowel due to any problem that causes ischemia to the blood supply of bowel*** *e.g. atrial fibrillation , thrombosis, emboli ,atherosclerosis* ***→resected bowel not enough to digest food→malnutrition)***
- Enteroenteric, enterocolic or enterocutaneous fistulae.
- Patients with high alimentary tract obstruction as achalasia, gastric cancer or gastric outlet obstruction.
- Malabsorption syndromes as sprue, hypoproteinemia & pancreatic insufficiency.
- Diseases of the absorptive mucosa as in granulomatous colitis, ulcerative colitis & tuberculosis.

NUTRITION OF THE SURGICAL PATIENT & METABOLIC RESPONSE TO INJURY

Wednesday , Nov 28 2007 , Dr. Omar Al-Farouk

Two main forms of parenteral nutrition

I) Peripheral Parenteral Nutrition.

II) Central (Total) Parenteral Nutrition **TPN.**

- Both differ in:
  - Composition of feed.
  - Primary caloric source.
  - Potential complications.
  - Method of administration.

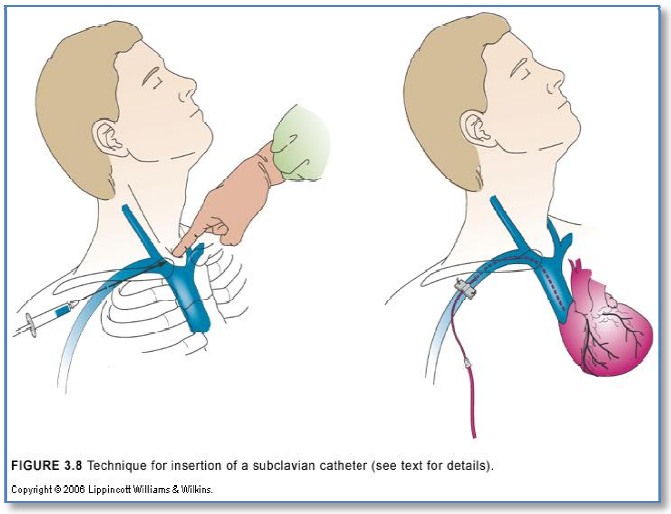


FIGURE 3.8 Technique for insertion of a subclavian catheter (see text for details).

Peripheral Parenteral Nutrition:

- Given through a peripheral vein
  - For short term use .
  - Mildly stressed patients.
  - Low caloric requirements .
  - Needs large amounts of fluid .
  - Cases contraindicated to central TPN.

What to do before starting TPN?

- Nutritional Assessment.
- Venous access evaluation.
- Baseline weight.
- Baseline lab investigations.

Venous Access for TPN:

(!) Needs venous access to a “large” central line with fast flow to avoid thrombophlebitis :

- Long peripheral line.
- Subclavian approach.
- Internal jugular approach .
- External jugular approach.
  - ➔ **Ultimately reaches the Superior Vena Cava.**

Baseline Lab Investigations:

- Full blood count.
- Coagulation screen.
- Urea & electrolytes.
- Ca^{++}, Mg^{++}, PO_4^{-2}
- Lipid Profile.
- Other tests when indicated.

NUTRITIONAL COMPONENTS:

- Carbohydrates.
- Fats.
- Proteins.
- Vitamins.
- Electrolytes.
- Trace elements.

How much CHO & Fats?

- Fats usually form 25 to 30% of calories.
- Not more than 40 to 50%.
- Increase usually in severe stress.
- Aim for serum TG levels < 350 mg/dl or 3.95 mmol / l.
- CHO usually form 70-75 % of calories.

(✡) How much protein to give?

- Based on calorie : nitrogen ratio.
- Based on degree of stress & body weight.
- Based on Nitrogen Balance.

Calorie : Nitrogen Ratio

- Normal ratio is (150 cal : 1g Nitrogen).
- Critically ill patients is (85 to100 cal :1 g Nitrogen).

Electrolyte Requirements:

Cater for maintenance + replacement needs

- **Na^+** 1 to 2 mmol/kg/d (or 60-120 meq/d).
- **K^+** 0.5 to 1 mmol/kg/d (or 30 - 60 meq/d).
- **Mg^{++}** 0.35 to 0.45 meq/kg/d (or 10 to 20 meq /d).
- **Ca^{++}** 0.2 to 0.3 meq/kg/d (or 10 to 15 meq/d).
- **PO_4^{-2}** 20 to 30 mmol/dl.

Table 3-9. Pharmacologic Formulation of the Nutrient Admixture

	(ml)	(g)	kcal
Amino acids (10%)	1000	100	400
Dextrose (70%)	700	490	1666
Fat emulsion (20%)	400	800	800
Free water	400		
Total Volume	2500 ml		
Protein		100g	
Energy			2866 kcal

To this were added electrolytes, vitamins, & trace elements as above

Trace Elements:

- The 14 trace elements that are considered essential for enzyme activities include magnesium, cobalt, molybdenum, vanadium.
- Zinc deficiency is manifest as a rash in the face & perineum, stomatitis & alopecia.
- Copper deficiency results in leucopenia & anemia.
- Total requirements not well established.
  - **Zn 2-4 mg/day**
  - **Cr 10-15 ug/day**
  - **Cu 0.3 to 0.5 mg/day**
  - **Mn 0.4 to 0.8 mg/day**

VITAMINS :

- Essential for the maintenance of the normal metabolic function.
- Water soluble vitamins B & C : **coenzymes in collagen formation & wound healing.**
- Fat soluble vitamins A,D,K & E: **reduced in steatorrhoea & obstructive jaundice.**

Other Additives:

- **Vitamins :**
  - Give 2-3x that recommended for oral intake.
  - give 1 ampoule MultiVit per bag of TPN.
  - MultiVit does not include Vit K.
  - Vitamin K 5-10mg i.m weekly reduces the bleeding tendency.
- **Medications :**
  - **Insulin**
    - can give initial SI based on sliding scale according to hypo count q6h (keep <11 mmol/l).
    - once stable, give 2/3 total requirements in TPN & review daily.
    - alternate regimes :
      - ***0.1 u per g dextrose in TPN.***
      - ***10 u per liter TPN initial dose***
  - **Other medications**

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TPN Monitoring:

- Clinical Review.
- Lab investigations.

→ **Adjust TPN order accordingly**

Clinical Review:

- Clinical examination.
- Vital signs.
- Fluid balance.
- Catheter care.
- Sepsis review.
- Blood sugar profile.
- Body weight.

Lab investigations *(see table):*

- Full Blood Count: weekly unless indicated.
- Renal Function: daily until stable & then 2x/week.
- Ca^{++}, Mg^{++}, PO_4: daily until stable & then 2x/week.
- Liver Function Test : weekly.
- Iron: weekly.
- Lipid Profile: weekly.
- Nitrogen Balance: weekly.

Complications related to TPN:

I) Mechanical Complications
II) Metabolic Complications
III) Infectious Complications

Mechanical Complications:

Related to vascular access technique:

- Catheter misplacement .
- Catheter embolism.
- Thoracic duct injury.
- Pneumothorax .
- Air embolism.
- Arterial injury.
- Brachial plexus injury.
- Bleeding.

Related to catheter in situ

- Venous thrombosis.
- Catheter occlusion.

Table 3-10. Monitoring Patients on TPN

Measurement	First Week	Condition is Stable
Body weight	Daily	Daily
Volume of infusate	Daily	Daily
Oral intake Daily	Daily	
Urine output	Daily	Daily
Plasma electrolytes	Daily	3X/wk
Plasma osmolality	Daily	3X/wk
Blood glucose	Daily	3X/wk
Hemoglobin	3X/wk	Weekly
Calcium	3X/wk	Weekly
Magnesium	3X/wk	Weekly
Triglycerides	3X/wk	Weekly
Urine		
Glucose	4-6X/day	2X/day
Sodium	As indicated	As indicated
Potassium	As indicated	As indicated

Metabolic Complications:

Abnormalities related to excessive or inadequate administration :

- Hyper / hypoglycemia .
- Electrolyte abnormalities.
- Acid-base disorders.
- Hyperlipidemia .

Hepatic complications :

- Biochemical abnormalities.
- Cholestatic jaundice.
  - *Too much calories (carbohydrate intake).*
  - *Too much fat .*
- Acalculous cholecystitis.

Infectious Complications

Insertion site contamination.

Catheter contamination:

- Improper insertion technique.
- Use of catheter for non-feeding purposes.
- Contaminated TPN solution .
- Contaminated tubing .

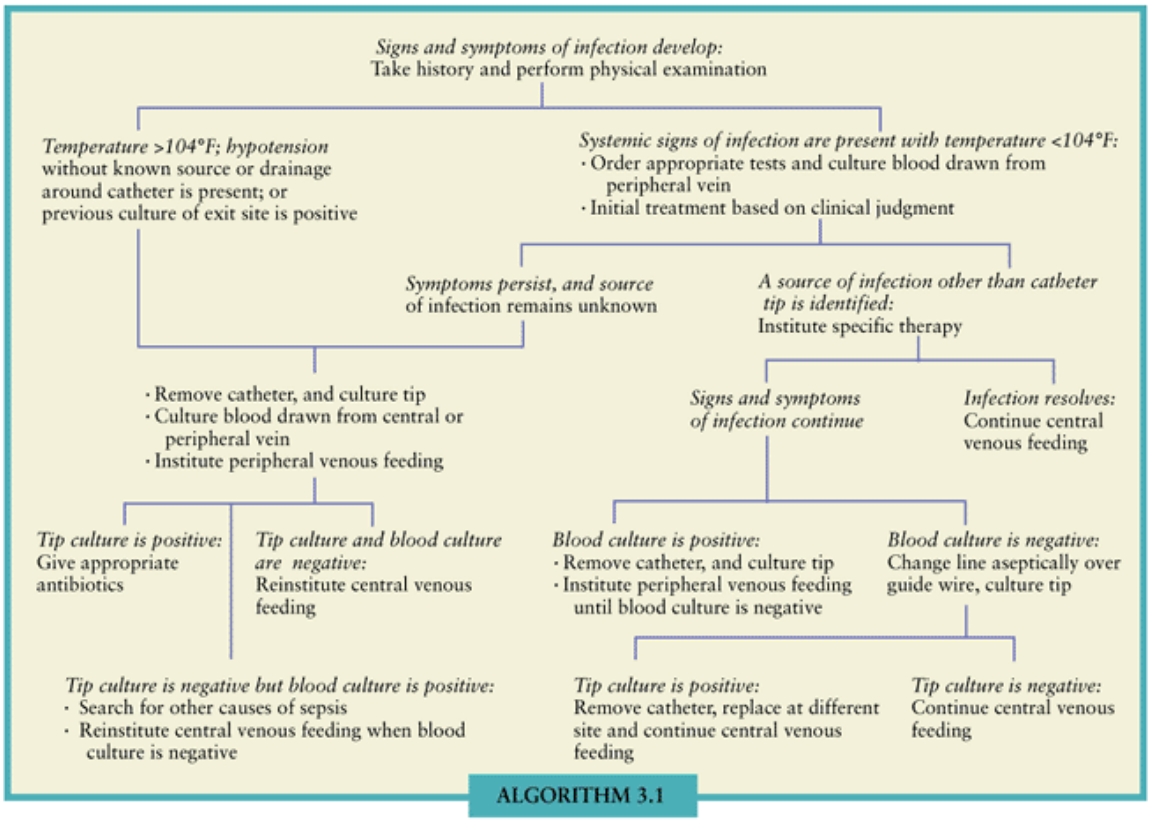
Secondary contamination:

- Septicemia ***(see table)***.

COMPLICATIONS ASSOCIATED WITH THE USE OF TPN MECHANICAL COMPLICATIONS		
Complication	**Cause**	**Treatment**
Pneumothorax	**Puncture/laceration of lung pleura**	**Serial CXRs; chest tube if indicated**
Subclavian artery injury	**Penetration of subclavian artery during needle stick**	**CXR; Serial monitoring of vital sign**
Air embolism	**Aspiration of air into the subclavian vein & right heart**	**Place patient in Trendelenburg & left lateral decubitus; aspirate air**
Catheter embolization	**Shearing off the tip when withdrawing catheter**	**Retrieve catheter transvenously under fluoroscopic guidance**
Venous thrombosis	**Clot formation in great vein secondary to catheter**	**Heparinization if clinically significant**
Catheter malposition	**Tip of catheter directed into IJ or opposite subclavian**	**Reposition under fluoroscopy**

METABOLIC COMPLICATIONS		
Hyperglycemia	Excessive glucose calories or glucose intolerance	Decrease glucose calories; administration insulin
Hypoglycemia	Sudden cessation of TPN	Bolus 50% glucose solution monitor blood glucose
Carbon dioxide retention	Infusion of glucose calories in excess of energy needs	Decrease glucose calories & replace with fat
Hyperglycemic, hyperosmolar non-ketotic coma (HHNC)	Dehydration from excessive diuresis	Discontinue TPN immediately; give insulin; monitor glucose/electrolytes
Hyperchloremic metabolic acidosis	Excessive chloride administration	Give Na & K as acetate salts
Azotemia	Excessive amino acid administration with inadequate calories	Decrease amino acids; increase glucose calories
Essential fatty acid deficiency	Inadequate essential fatty acid administration	Administer fat solution
Hypertriglyceridemia	Rapid fat infusion of decreased fat clearance	Slow rate of fat infusion
Hypophosphatemia , Hypocalcemia Hypomagnesemia , Hypokalemia	Inadequate administration of electrolyte in question	Increase administration
Bleeding	Vitamin K deficiency	Administer vitamin K

SEPTIC COMPLICATIONS		
Line sepsis	**Catheter tip infected**	**Remove catheter; antibiotics**
Infection at skin site	**Bacteria at site of catheter entry into skin**	**Remove catheter; local wound care**



ALGORITHM 3.1

- **(☒) Stopping TPN:**
  - ✳ Stop TPN when enteral feeding can restart .
  - ✳ Wean slowly to avoid hypoglycemia.
  - ✳ Monitor hypo counts during wean.
    - ♦ **Give IV Dextrose 10% solution at previous infusion rate for at least 4 to 6h .**
    - ♦ **Alternatively, wean TPN while introducing enteral feeding & stop when enteral intake meets the demand.**

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KEY POINTS :

1) The goal of perioperative or post-traumatic nutritional support is to replete or maintain protein & energy stores as a part of lean body mass, to allow recovery from illness.

2) Inflammation can increase energy utilization & alter the metabolism of glucose, protein, fat & trace mineral metabolism.

3) To identify nutritional requirements, estimate basal metabolic rate for age, gender, & body surface area & increase by 25% to 100% based on severity of stress.

4) Use the enteral route for feedings when practical.

5) Assess the adequacy of nutritional support to determine further needs.