Percutaneous Endoscopic Gastrostomy (PEG) and Enteral Feeding

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Indications for PEG

- Prediction or evidence of oral intake quantitatively or qualitatively inadequate for more than 3 weeks.
- Inability to stabilize or improve the nutritional status with the use of oral supplements and tips to improve swallowing (if needed).
- Expectation that the PEG feeding will maintain or improve the quality of life.
- Palliative drainage of juices in gastrointestinal stenosis or chronic bowel ileus
- Purpose:
  - prevent loss of weight,
  - correct nutritional deficiencies,
  - rehydrate,
  - promote the growth of children with growth retardation, and
  - improve the quality of life.

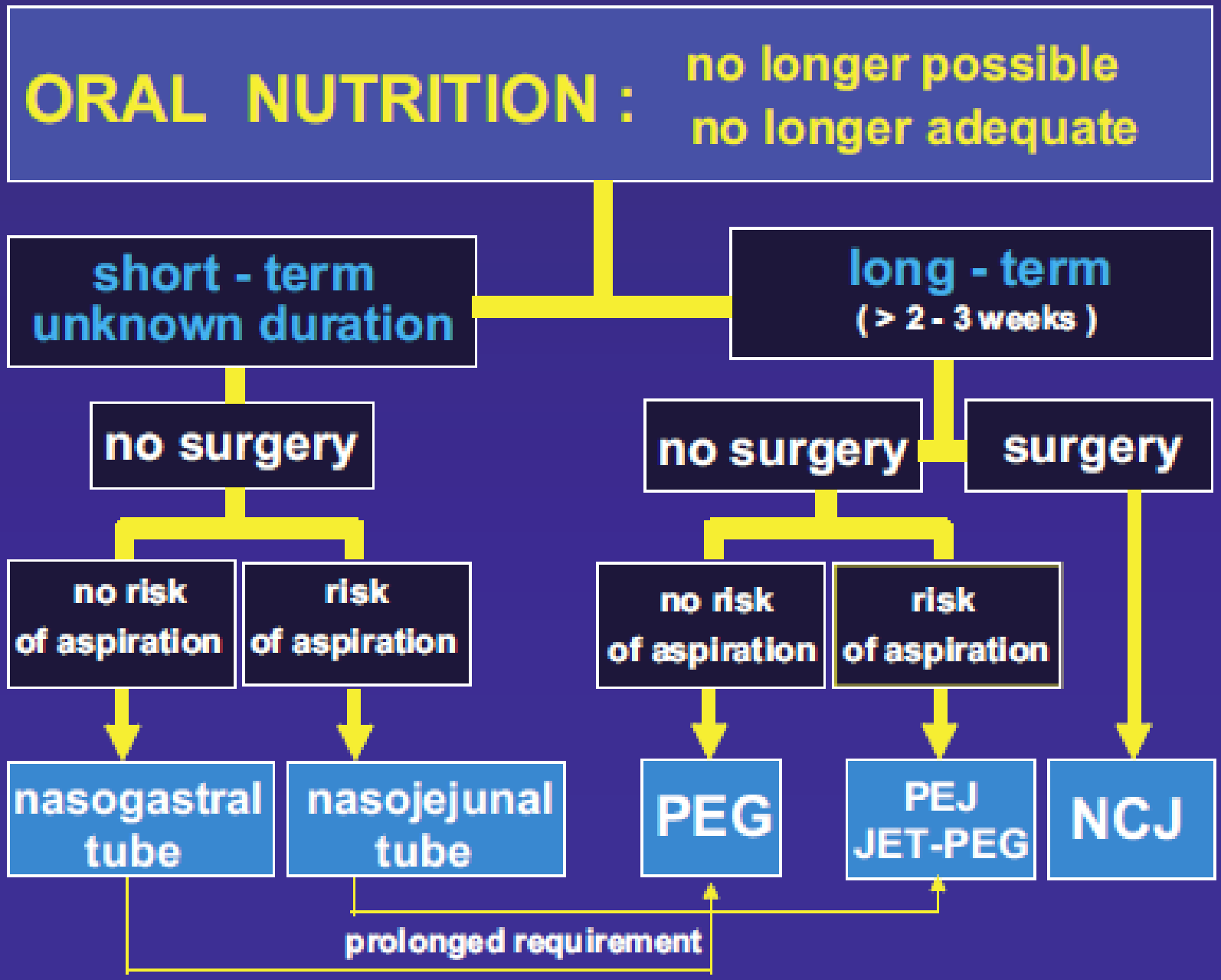
Types of Enteric Access

Gastric Tubes

- Nasogastric tube
- PEG (Ponsky, Sachs-Vine, Russell, o Brown-Muller (Versa))
- Laparoscopic gastrostomy
- Surgical Gastrostomy (Witzel, Stamm, Janeway)
- Ultrasound guided Percutaneous Gastrostomy
- Fluoroscopy Guided Percutaneous Gastrostomy
- Gastrostomy with Jejunal tube

Jejunal Tubes

- Nasojejunal tube
- Direct Percutaneous Endoscopic Jejunostomy
- Laparoscopic Jejunostomy
- Surgical Needle Catheter Jejunostomy
- Ultrasound Guided Percutaneous Jejunostomy
- Fluoroscopy Guided Percutaneous Jejunostomy


ORAL NUTRITION :
no longer possible
no longer adequate
short - term
unknown duration
long - term
(> 2 - 3 weeks)
no surgery
no surgery
surgery
no risk
of aspiration
risk
of aspiration
no risk
of aspiration
risk
of aspiration
nasogastral
tube
nasojejunal
tube
PEG
PEJ
JET-PEG
NCJ
prolonged requirement

Advantages of PEG

- Less discomfort and complications than NG tube for a long time:
  - Less: irritation, ulceration, esophageal bleeding, displacement, obstruction of tube, reflux, aspiration pneumonia, cosmetic inconvenience, and
  - Greater: social acceptance.
- Weight gain is higher than that obtained with NG tube.
- Fewer complications than with surgical and laparoscopic gastrostomy
- The literature on prevention of reflux and aspiration using DPEJ or PEG with jejunal tube is controversial.

Long Term Complications of PEG

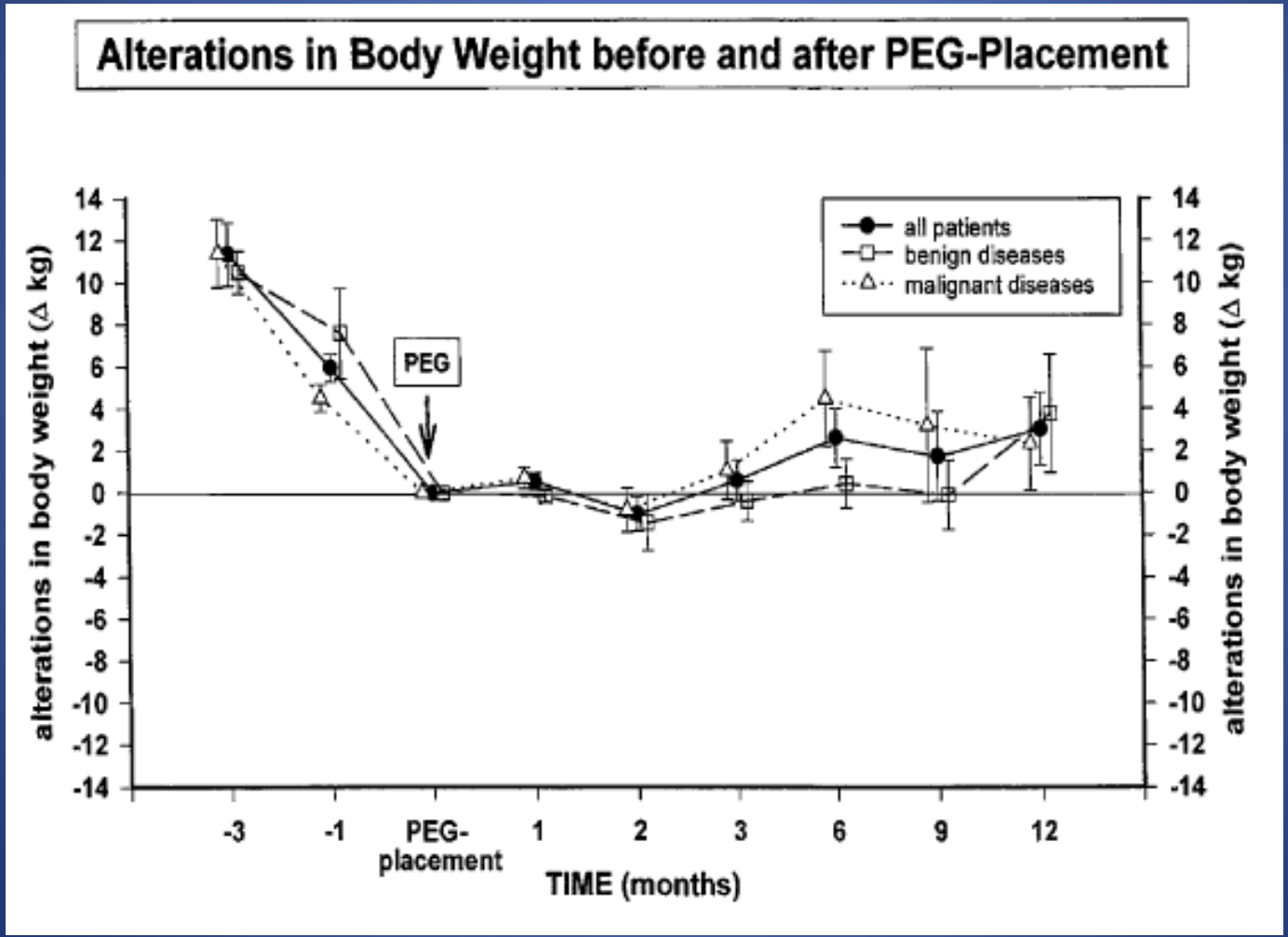
- General Complications 4.9-10.8%
  - Complications needing intervention: 1-4%
  - Complications needing surgery: 0.5%
- Risk Factors – Malnutrition, advanced cancer, outpatient procedure.
- Mortality

  Procedure related : <1%

  Long Term: 0.6-2.0%
- Little change in Mortality and Morbidity over the last 10-15 years.

Larson (Gastro 1987;93:48) Lin (Laryngoscope 2001;111:1847)
Grant (Ann Surg 1993;217:168) Rimon (Endosc 2001;33:241)

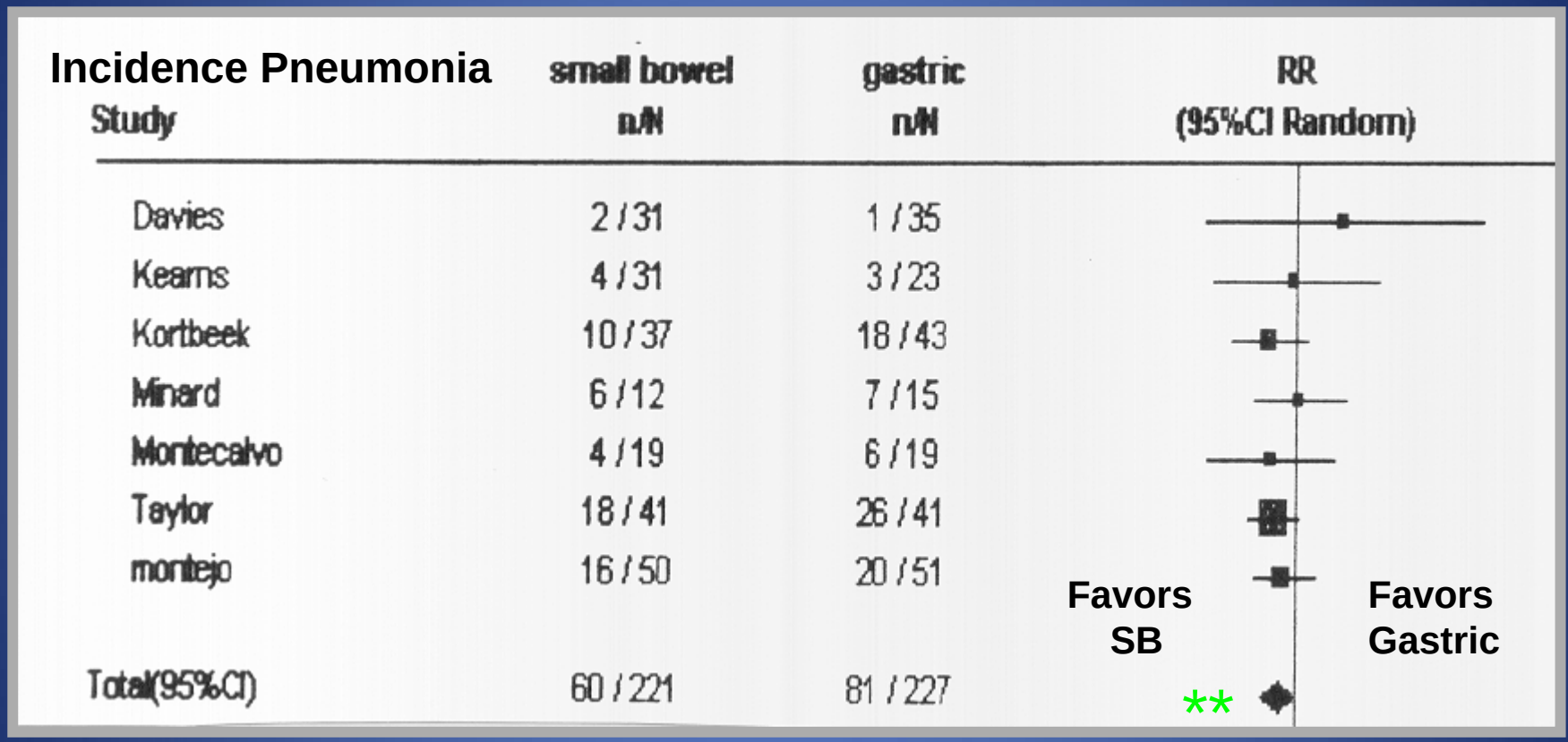
Effects of PEG Feeding on the Weight of Patients



Loser et al., Dig Dis Sci 1998; 43: 2549-2557

Modifying Risk of Pneumonia

Alimentation Site



n = # pneumonia , N = # in group

** RR 0.76 (95% CI 0.59 – 0.99)

DK Heyland [JPEN 2002;26(6):Supplement]

PEG Contraindications

CURRENT

- Coagulopathy (INR > 1.7, PTT > 50, platelets < 50000)
- Interposed Organ (liver, colon).
- Severe Peritoneal Carcinomatosis
- Severe Non-cirrhotic Ascites
- Cirrhotic Ascites
- Peritonitis
- Anorexia Nervosa (?)
- Severe Psychosis
- Gastric Tumor infiltration in site of PEG
- Short Survival
- Advanced Dementia
- Peritoneal dialysis in adult

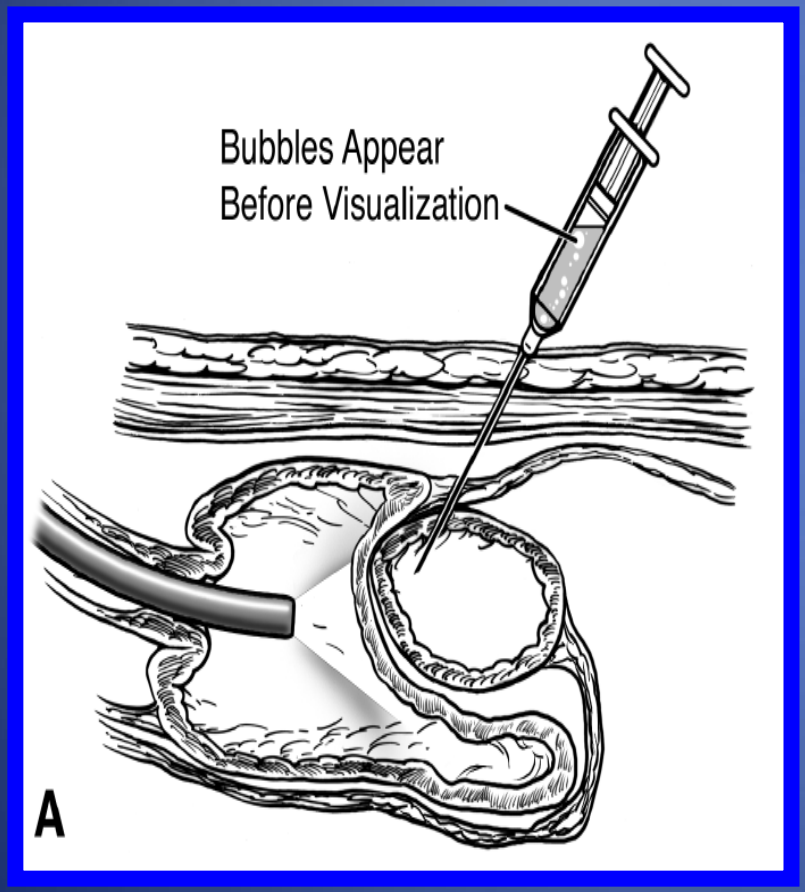
HISTORICAL: Now False

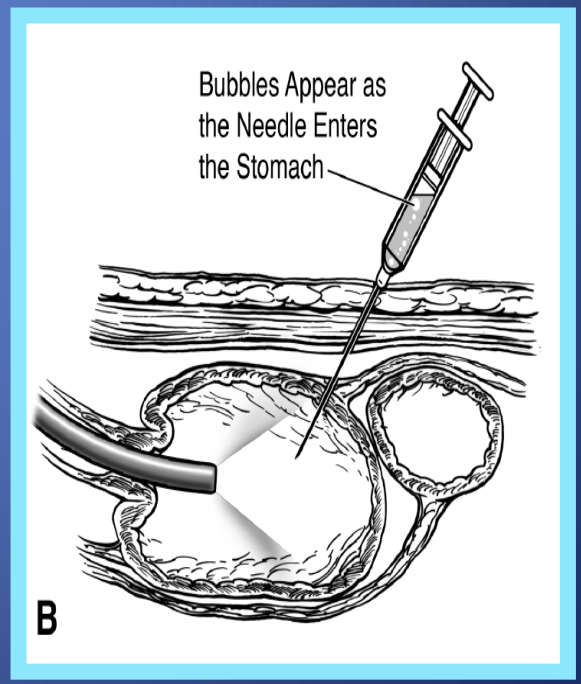
- Negative Diaphanoscopy (now we use “Foutch safe tract”)
- Ventriculo-peritoneal Shunt.
- Peritoneal Dialysis (in children)
- Esophageal Stricture
- Previous Gastric Surgery
- Crohn Disease
- Non-cirrhotic mild or moderate ascites

Precautions to Minimize PEG Complications

- Cleaning of the oral cavity before the procedure
- Cefazolin 2 g IV 1 hour before PEG.
- Skin Cleansing with chlorhexidine
- Use “Foutch Safe Tract” technique.
- Skin Incision slightly loose (> 8 mm) .
- External “Bumper” slightly loose (free movement > 5 mm while patient at 45^0).
- Place sterile gauze with “Y” shape between the skin and the external bumper; change daily for 14 days, cleaning with sterile saline solution.
- After 14 days, cleanse with soapy water every 2-3 days, and place a new sterile gauze with “Y” shape.
- Feeding can start 2 hours after PEG placement.

Foutch Safe Tract Technique





Precautions to Ensure Adequate Volume Administration of Enteral Nutrition

- Calculate the nutritional need of the patient.
- Give the formula without dilution (adding water facilitates infection)
- Keep thorax and head elevated 30-45^0
- When starting, advance the volume/hour rapidly:
  - 35% of desired volume/hour for 4-8 hours, then
  - 70% for 4-8 hours, then
  - 100% thereafter.
- If the patient is malnourished or has not been fed for 2 weeks or more, watch carefully for development of “Re-feeding Syndrome”.
  - Obtain K, P, Ca and Mg every 8-12 h and replace deficiencies; give thiamine 300-500 mg, followed by 100 mg/d + B-complex TID + Multivitamins with Minerals daily
  - Advance to the feeding “goal rate” more slowly (start with 10 kcal/kg/d, and increase by 5 kcal/kg/d every 2-3 days).

Precautions to Ensure Adequate Volume Administration of Enteral Nutrition

- Order the total volume to be fed, and deliver it over 12-20 hours (calculate volume/hour over that period)
  - Multiple studies show that when feeding in the hospital over 24 hours, the delivered volume is < 80% of the one ordered.
- Watch for “gastric residual volume” only in gastric feeds.
  - If “residual volume” is < 400 mL, return it to the stomach and continue feeding, unless there is evidence of regurgitation.
  - If “residual volume” is > 400 mL, return it to the stomach and add pro-kinetics, or change to small bowel feeding.
- Open feeding systems must be changed every 4 hours; close feeding systems can last up to 48 hours.

Groups with Strong Evidence of Benefits from PEG Feeding

- AIDS/ HIV Infection:
  - Improve treatment compliance in children.
  - Improves nutrition in adults with “wasting syndrome”.
- Cystic Fibrosis:
  - Night feeding by PEG improves nutrition, stabilizes lung function, and is superior to naso-gastric feeds.
  - Maximal improvement is reached with early PEG placement.
- Amyotrophic Lateral Sclerosis (ALS):
  - PEG must be placed early in the illness (Vital Capacity > 50% of predicted; VC >/= 1 L, and pCO_2 < 45 mm Hg)
  - The stomach must be actively decompressed at the end of the procedure, to improve diaphragmatic function.
- Severe Mental and Physical Retardation:
  - Improves nutrition and quality of life in adults and children.

Enteral Nutrition in Specific Groups

Indications for Oral Supplements in Geriatric Patients

(sick elderly: protein >/= 1g/kg/d & calories = 30 kcal/kg/d)

- Malnourished or at Risk of Under-nutrition
  - Loss of 5% of weight / 3 months, or
  - Loss of 10% of weight /6 months, or
  - BMI < 20/m^2
- Frail Elderly (> 64 y/o)
  - Decreases frequency of falls
  - Decreases mortality
- Hip fracture or Orthopedic Surgery
  - Decreases complications and mortality
- Mild or Moderate Dementia
- Prevention of pressure ulcers
  - Decrease incidence by 25%

Indication for Tube Feeding in the Geriatric Patient

(sick elderly: protein >/= 1g/kg/d & calories = 30 kcal/kg/d)

- Non-terminal Frail Elderly
- Depression with severe anorexia.
- Treatment of pressure ulcers
- Severe Neurologic Dysphagia
  - Immediate naso-enteric tube + intensive swallowing therapy (decreases hospital stay)
  - After an stroke, 73-86% of patients recover from dysphagia within the initial 2 weeks:
    - Place PEG if not improved in 2 weeks
  - PEG feeding gives 90% of prescribed calories, vs NGT gives on 62%.
- Mild to Moderate Dementia (occasional use)
- If expected need for tube feed is > 4 weeks, place PEG.
- Add fiber to the formula.

Enteral Nutrition in Patients with Crohn Disease

- **Indications:**
  - Prevention and Treatment of Malnutrition.
  - Improvement in Growth and Development in Children and Adolescents.
  - Improvement in Quality of Life.
  - Peri-Operative Nutrition.
  - Treatment of Active Disease:
    - Children: Therapy of choice (60% remission = corticosteroids);
    - Adults: when corticosteroids are not well tolerated (EN 60% remission vs corticoids 60-**80**%) , or in combination with corticosteroids in patients with malnutrition or inflammatory stricture of the bowel.
  - Maintenance of Remission:
    - Oral night supplement, after induction of remission, prolongs free-recurrence interval independently of disease location (small bowel, colon, or both).

Enteral Nutrition in Patients with Crohn Disease

- **Route:**
  - If caloric supplement needs are < 600-750 kcal/d, give oral supplementation at hs.
  - If needed caloric supplementation is higher, give by NGT or PEG, by continuous infusion (not by bolus).
    - Discontinuation of supplements is higher when given orally (34%), than when given by NGT (8%).
- **Formula:** (25-30 kcal/kg/d of total intake: oral + tube)
  - Standard (whole protein) which should be high on (n6 PUFA) linoleic acid and low in (n9 MUFA) oleic acid.
  - Calcium 1200 mg/d, Vitamin D 1000 UI/d.
  - May need supplements of: Vitamin B_{12} (involved ileum), Folate (sulfasalazine use), Mg, P, K, and Zn.

Enteral Nutrition in Patients with **Ulcerative Colitis**

- **Indications:**
  - Risk of Malnutrition due to Low Nutritional Intake.
  - Malnutrition
  - *(There is no evidence that enteral or parenteral nutrition affect inflammatory activity, nor affect the frequency of flare ups in active UC).*
- **Route:**
  - Oral or by tube
- **Formula:**
  - Whole Protein.
  - Omega-3 enriched formulas improve the “histologic index” but have no proven clinical effect.

Enteral Nutrition in Patients with **Short Bowel**

- **Indications:**
  - Maintenance or Improvement of Nutritional Status.
  - Improvement of Residual Intestinal Function.
  - Reduction of diarrhea.
  - Improvement of Quality of Life.

Enteral Nutrition in Patients with **Short Bowel**

- **Route:**
  - ***Hypersecretory Phase*** *(Stool output > 2500 mL/d)**:*** Parenteral + Oral Rehydration Solution
  - ***Adaptation Phase*** *(Stool output < 2500 mL/d)* ***:*** Parenteral + Enteral with increasing volume.
    - Start peptide-based formula (like Vital 1.5) + Na supplementation (NaCl or $NaHCO_3$) to make a total Na of 80-1**00** mEq/L of formula (to use the co-transport of Na and glucose)
  - ***Maintenance Phase:*** oral diet + supplements or tube feeds as needed.
    - May still need Oral Rehydration Solution.
    - If Stool output weight is 3 kg/d or more while feeding 2500 kcal/d, patient likely will need supplemental parenteral nutrition.

Enteral Nutrition in Patients with **Short Bowel**

- **Formula:**
  - Regular Diet
  - Peptide-based formula with Na supplementation during “adaptation”, and
  - Whole-protein Formula for “Maintenance”.
  - Calorie-intake should be corrected by the % of absorbed fat (example: if when giving 100 g fat/day diet, the patient absorbs only 40 g (40%), the patient should receive enterally 100%/0.4 = 250% of the nutrients that he/she needs.
  - When supplementing with Parenteral nutrition, subtract from calorie-needs the calories absorbed in GI tract, by multiplying (oral calorie intake) by (% of fat absorbed).

Enteral Nutrition in Patients with **Alcoholic Hepatitis**

- **Indications:**
  - Alcoholic Hepatitis with Malnutrition.
  - Severe Alcoholic Hepatitis
    - with Maddrey Discriminant Function > 32;
      [Discriminant Function = 4.6 * ($PT_{patient} - PT_{control}$) + Total Bilirubin] , &
    - not fulfilling his/her nutritional needs with oral diet
- **Nutritional Needs:**
  - Calories: 35-40 kcal/kg/d
  - Protein: 1.2-1.5 g/kg/d

Enteral Nutrition in Patients with **Alcoholic Hepatitis**

- **Route:**
  - Oral supplementation with meals and at bedtime (500-750 kcal + 20 g protein @ hs)
  - Naso-enteric Tube
  - HIGH RISK for REFEEDING SYNDROME.
  - Do not use PEG: high complication risk in these patients
- **Formula:**
  - Whole-protein Formula
  - Branched-chain amino acid enriched Formula in “Hepatic Encephalopathy” (NUTRIHEP).
  - Aggressive Nutrition increases Survival at 1, 3, and 12 months.

Enteral Nutrition in Patients with **Cirrhosis**

- **Indications:**
  - Malnourished cirrhotic
  - Inability to fulfill nutritional needs with oral diet (usually 2 g sodium/d)
- **Nutritional Needs:**
  - Protein: 1.2-1.5 g/kg/d
  - Calories: 30-40 kcal/kg/d

Enteral Nutrition in Patients with **Cirrhosis**

- **Route:**
  - Oral: 3 meals + 3 snacks + 500-750 kcal with >/= 20 g protein at bedtime (2 Ensure-plus or 2 Glucerna)
  - Naso-enteric tube.
  - Do not place PEG due to high complication risk.
- **Formula:**
  - Whole-protein Formula
  - Brached-chain amino acid enriched Formula (NUTRIHEP) in hepatic encephalopathy.
  - Aggressive nutrition improves encephalopathy and nutritional status, decreases complications, and improves survival.
  - Early feeding after liver transplantation, oral or enteral, decreases infectious complications..

Enteral Nutrition in Patients with **Acute Pancreatitis**

- **Indications:**
  - Mild acute pancreatitis with persistent pain for 5 or more days.
  - Severe acute necrotizing pancreatitis (even with ascites, fistula, or pseudocyst), defined by one of the following:
    - Three or more Ranson criteria
    - CT of abdomen with evidence of pseudocyst, abscess, or necrosis.
    - SIRS defined by 2 or more of the following criteria, for more than 48 hours:
      - pulse >90 beats/min;
      - rectal temperature < 36º C or > 38º C;
      - leucocytes < 4000 or >12,000 per mm^3;
      - respirations > 20/min or pCO_2 < 32 mm Hg.
    - Persistent failure of 1 of the following organs for 3 consecutive days:
      - ***Respiratory***: (pO_2/FiO_2) </= 201; or
      - ***Renal:*** Creatinine >/= 1.9; or
      - ***Circulatory***: systolic pressure < 90 mm Hg and not responsive to fluids.

Enteral Nutrition in Patients with **Acute Pancreatitis**

- **Route:** (all patients should receive aggressive intravenous fluid resuscitation)
  - Naso-gastric tube feeding (unless post-pyloric obstruction is present)
  - Naso-jejunal tube feeding (placed beyond point of obstruction)
  - Parenteral Nutrition, only if can not feed in the GI tract for 5 or more days (start the 6^{th} day).
- **Formula:**
  - Peptide-based Formula
  - Some patients may tolerate whole-protein formula.

Enteral Nutrition in Patients in the **Intensive Care Unit**

- **Indications:**
  - Any patient who is likely not to eat within 3 days and who is hemodynamically stable.
  - **Timing:**
    - Start within the first 24 hours from ICU admission, as soon as the patient has been “resuscitated”, with a MAP of 60 mm Hg or more while on low-dose vasopressors or without them.
    - Intestinal borborigmy is not needed to start enteral feedings.

Enteral Nutrition in Patients in the **Intensive Care Unit**

- **Nutritional Needs:**
  - Calories in the initial 96 hours (count propofol calories)
    - If BMI < 30: 20 kcal/kg/d.
    - If BMI > 30: 14 kcal/kg actual weight (20-25 kcal/kg ideal body weight)
  - Calories while in recovery (> 96h): 25-30 kcal/kg/d (count propofol calories)
  - Protein:
    - BMI < 30: 1.2 to 2 g/kg of “Ideal body weight”;
    - BMI 30-40: 2 g/kg of “Ideal body weight”;
    - BMI > 40 or hemodialysis patients: > 2.5 g/kg “Ideal body weight”

Enteral Nutrition in Patients in the **Intensive Care Unit**

- **Route**: (All patients in ventilator should have mouth washing with chlorhexidine every 12 h)
- Naso-gastric (+/- pro-kinetics) o Naso-jejunal
- Do not hold feeding unless:
  - Residual gastric volume is > 500 mL (change to naso-enteric tube), or
  - Patient can not tolerate feeding (abdominal pain, abdominal distention, ileus in abdominal X-Ray)
- Give parenteral nutrition only if:
  - Can not feed in GI tract for more than 7 days
  - There is evidence of malnutrition at ICU admission, and can not feed in GI tract (start parenteral nutrition from day 1)

Enteral Nutrition in Patients in the **Intensive Care Unit**

- **Formula:**
  - Whole-protein formula in: most cases.
  - **Immune Formula (Pivot, Crucial, Impact, Peptinex 1.5)** in:
    - patients needing upper GI tract surgery for cancer,
    - mild sepsis (APACHE II < 15),
    - trauma,
    - burns,
    - head and neck cancer needing surgery.
  - **Antioxidant Formula (Oxepa)** in:
    - ARDS, or
    - Acute Lung Injury
  - Add supplement of 0.5 g/kg **Glutamine**/day, divided TID, in:
    - Burns,
    - Trauma.
  - Control hyperglycemia with insulin, keeping "moderate control" with goal between 144-180 mg/dL (to minimize hypoglycemia episodes)

Enteral Nutrition in Patients in the **Surgical Patient**

- **Pre-Operative Indications:** (give enteral nutrition for 10-14 days before surgery).
  - Weight loss > 10% in 6 months.
  - BMI < 18.5 kg/m_2
  - Albumin < 3 g/L (not due to liver nor renal disease)
  - Subjective Global Assessment C:
    - Severe loss of subcutaneous tissue, muscular wasting, and edema.
  - High probability or current evidence of
    - Not eating for > 7 days, or
    - Food intake < 60% of nutritional needs for > 10 days

Enteral Nutrition in Patients in the **Surgical Patient**

- **Post-operative Indications:** High probability or current evidence of
  - not eating > 7 days, or
  - Food intake < 60% of needs for > 10 days
  - Mayor surgery for head and neck cancer
  - Mayor upper GI tract surgery for cancer
  - Severe Trauma
  - Malnutrition before surgery
- **Timing & Location:**
  - start within the 1st 24 hours after surgery, giving 20 mL/h of formula and increasing rate progressively.
  - Place "needle jejunostomy" or naso-enteric tube reaching beyond intestinal anastomosis site.

Enteral Nutrition in Patients in the **Surgical Patient**

- **Route:**
  - Prefer oral or enteral nutrition; add parenteral nutrition only if enteral provides < 60% of needs.
  - Parenteral only in:
    - intestinal obstruction,
    - paralytic ileus,
    - severe shock, or
    - intestinal ischemia.
  - **NO NPO after MN:** Give "Carbohydrate Load" to all patients having elective surgery (decreases post-operative insulin resistance and negative nitrogen balance):
    - 800 mL of water with 17 level tablespoons of Polycose (102 g) (osmolarity 225) [or 800 mL of Pre-OP, Nutricia] given orally the night before surgery, and
    - 400 mL of water with 8.5 leveled tablespoons of Polycose (50 g) [or 400 mL of Pre-OP, Nutricia] , 2 hours before surgery.

Enteral Nutrition in Patients in the **Surgical Patient**

- **Formula:**
  - Whole-Protein in most patients.
  - Immune Formula (omega-3, arginine, nucleotides) in the following groups:
    - Major neck surgery (laryngectomy, pharyngectomy),
    - Cancer of the upper GI tract (esophagus, stomach, duodenum, pancreas) with surgery
    - Major Trauma.

Enteral Nutrition in Acute Kidney Injury, or Acutely Ill with Chronic Kidney Disease

- Macronutrient needs are driven by:
  - the severity of the underlying disease, and
  - presence of underweight or obesity.
- Patients with CKD with acute illness behave metabolically as AKI patients.
- Protein Catabolism is increased:
  - Several non-essential amino acids become conditionally essential (tyrosine).
- Micronutrients:
  - Plasma retinol levels are elevated; toxicity risk.
  - Vitamin C in excess of 50 mg/d may cause oxalosis.
  - There is increased needs of Ca, Mg, Se, and Thiamine.

Enteral Nutrition in Acute Kidney Injury, or Acutely Ill with Chronic Kidney Disease

- Hyperglycemia develops from:
  - insulin resistance and
  - gluconeogenesis that is not suppressed by exogenous nutrients.
- There is inhibition of lipolysis with hypertriglyceridemia.
- Undernutrition in AKI patients:
  - increases length of stay and
  - Increases in-hospital mortality.
- Use of “Continuous Renal Replacement Therapy” (CRRT) causes significant loss of small molecules (protein & AA loss of 15-25 g/d; loss of water soluble vitamins).
- CAPD increases protein loss by 5-15 g/d + trace elements; absorption of glucose in PD fluid causes obesity, hypertriglyceridemia, hyperglycemia, and worsens diabetes.
- Intermittent hemodialysis increases losses in a lesser degree.

Enteral Nutrition in Acute Kidney Injury, or Acutely Ill with Chronic Kidney Disease

- Indications:
  - Undernutrition.
  - Inability to cover nutritional needs with oral diet + supplements.
  - Unlikely to eat within 3 days.
- Timing: within 24 hours
- Route:
  - Oral + night supplements;
  - If not enough NG tube;
  - If poor gastric emptying, NJ tube;
  - Sometimes parenteral supplementation.
- Formula:
  - Standard in most patients.
  - Renal formula for electrolyte problems.

Enteral Nutrition in Acute Kidney Injury, or Acutely Ill with Chronic Kidney Disease

- Nutritional Needs:
  - Energy: 20-30 kcal/kg/d (adapted to obesity or undernutrition).
  - Carbohydrates: 3-5 g/kg/d (max 7 g/kg/d)
  - Fat: 0.8-1.2 g/kg/d (max 1.5 g/kg/d)
  - Protein:
    - Conservative therapy: 0.6-0.8 g/kg/d (max 1 g/kg/d)
    - CRRT or hypercatabolism: up to 1.7 g/kg/d
    - Intermittent hemodialysis: 1-1.5 g/kg/d

Enteral Nutrition in CKD on Conservative Therapy

- Indications:
  - When diet + night supplements do not cover needs;
  - Give special attention to elderly patients.
- Nutritional Needs:
  - Calories:
    - 35 kcal/kg/d if in IBW +/- 10%;
    - increase if undernourished; decrease if overweight.
  - Protein:
    - GFR 20-70 mL/min: 0.55-0.6 g/kg/d (2/3 High Biological Value)
    - GFR < 25 mL/min: 0.6 g/kg/d (2/3 High Biological Value), or 0.28 g/kg/d + {Essential AA +/- Ketoanalogues}
  - Minerals:
    - Phosphate 600-1000 mg/d
    - Potassium 1500-2000 and mg/d
    - Sodium 1800-2500 mg/d

Enteral Nutrition in CKD on Conservative Therapy

- Route:
  - Oral + Night supplements; if not enough;
  - Overnight or continuous tube feeds.
- Formula:
  - If < 5 days: Standard
  - If for 5 or more days:
    - Renal formula, or
    - Very low protein formula PLUS essential aminoacids and ketoanalogues

Enteral Nutrition in CKD on Maintenance Hemodialysis

- Indication: Undernutrition as documented by
  - BMI < 20 kg/m2
  - Weight loss > 10% over 6 months
  - Albumin < 3.5 g/dL, or pre-albumin < 30 mg/dL
- Nutritional Needs:
  - Calories:
    - HD or CAPD = 35 kcal/kg/d
  - Protein:
    - HD: 1.2-1.4 g/kg/d (> 50% High Biological Value)
    - CAPD: 1.2-1.5 g/kg/d (>50% High Biological Value)
  - Minerals & Vitamins:
    - Phosphate 800-1000 mg/d; Potassium 2000-2500 mg/d; Sodium 1800-2500 mg/d; Fluid: 1000 mL + urine volume/d; Zn 15 mg/d; Se 50-70 mcg/d
    - Folic acid 1 mg/d; Pyridoxine 10-20 mg/d; Vitamin C 30-60 mg/d; Vitamin D

Enteral Nutrition in CKD on Maintenance Hemodialysis

- Route:
  - Oral + bedtime supplements +/- supplement during dialysis; if not enough, then
  - Tube feeds: NGT or NJT; may need PEG or DPEJ
- Formula: Renal formula

Enteral Nutrition (EN) in Cardiology

- **EN is indicated in cardiac cachexia to stop or reverse weight loss (physiologic plausibility).**
  - 1% of population has CHF; mortality is 50% at 5 y.
  - **Cardiac cachexia:** weight loss of >/= 6% of weight over 6 months.
  - 12-15% of NYHA class II-IV have cardiac cachexia.
  - In NYHA class III-IV cardiac cachexia will develop @ 10%/year.
  - Muscular atrophy develops in 50% patients without weight loss with CHF NYHA II-III.
  - Patients with cardiac cachexia have increased **resting** energy expenditure; overall energy expenditure is decreased b/o decreased activity.
  - Anorexia is present in 10-20% of cardiac cachexia patients.

Enteral Nutrition (EN) in Cardiology

- EN is indicated in cardiac cachexia to stop or reverse weight loss.
  - Mortality in CHF with cardiac cachexia is 2-3 fold higher than in non-cachectic CHF.
  - Weight gain associated with beta-blocker use (anti-catabolic effect) leads to better survival and less hospitalizations. ACE inhibitors prevent weight loss.
  - EN for 24 weeks improves exercise capacity and increases lean body mass in CHF NYHA III/IV (Arutiunov GT et al Kardiologiia 2003;43(5):52-55)
- RECOMMENDATION:
  - We need studies evaluating the effect of nutritional support (oral or by feeding tube) in Cardiac Cachexia.
  - Until data are available, give supplementation at bedtime, to cover increased resting energy expenditure and increase lean body mass (500 – 750 kcal, with >/= 20 g protein at bedtime)

Enteral Nutrition (EN) in Pulmonology

- **Cystic Fibrosis:**
  - Night feeding by PEG improves nutrition, stabilizes lung function, and is superior to naso-gastric feeds (Akobeng AK et al. J Pediatr Gastroenterol Nutr 1999;29:1089–93).
  - Maximal improvement is reached with early PEG placement.
- **COPD:**
- Effects of COPD in nutrition and in Energy and Substrate Metabolism:
  - 25-40% of patients with advanced COPD are malnourished.
  - Severe weight loss (5% of weight over 3 months, or 10% of weight over 6 months) is seen in 25-40% of patients with FEV1 < 50%.
  - Muscular wasting (fat-free mass index < 16 kg/m2 in males or < 15 kg/m2 in females is present in 25% of GOLD stages 2 and 3, and in 35% of GOLD 4.
  - Lean body mass depletion is more common than low BMI.
  - There is increased rate of osteoporosis in COPD.
  - Patients with COPD are hyper-catabolic (increased resting energy expenditure, increased respiratory work, chronic inflammation)
  - Compensatory anabolism is insufficient due to hormonal resistance in COPD.
  - Anorexia and decreased food intake are common in COPD.

Enteral Nutrition (EN) in Pulmonology

- Influence of nutrition on the prognosis of COPD.
  - Underweight and low fat-free mass are associated with poor prognosis in respiratory insufficiency (FEV1 < 50%) (mean survival of 2-4 years).
  - Patients with BMI < 25 have best survival if they gain weight.
  - Patients with BMI >/= 25 do better when weight remains stable.
- There is limited evidence that COPD patients benefit from EN
  - Cochrane review of caloric supplementation in stable COPD (Ferreira IM et al. Cochrane Database Syst Rev. 2002;1:CD0000998) did not show benefit, however many patient did not increase calorie intake (exchanged food for supplements). In patients who increased calorie intake there was functional improvement.
  - Studies that provide nutritional support as part of pulmonary rehabilitation show beneficial effects.

Enteral Nutrition (EN) in Pulmonology

- EN plus anabolics and exercise can potentially improve nutrition and function.
  - In a study (Schols AMWJ et al Am J Respir Crit Care Med 1998;157:1791-7) patients with COPD received a supplement with 420 kcal (51% as fat), and 14.7 g protein and intramuscular nandrolone decaonate 50 mg in males, and 25 mg in females, given every 14 days. Fifty % of the patients gained > 2 kg over 8 weeks, and they had lower mortality.
- RECOMMENDATION:
  - There is need for prospective, randomized studies of nutrition supplementation in patients with advanced lung disease. Studies could compare bedtime supplementation alone and in combination with anabolic steroids, vs placebo.
  - Meanwhile, supplementation with “Nepro with Carb Steady” [425 kcal (48% cal from fat), with 19 g protein] at hs could improve nutrition without replacing other meals.

Re-Feeding Syndrome

- DEFINITION: Severe fluid and electrolyte shifts associated with initiating nutrition support in malnourished patients, and the metabolic implications which occur as a result of this shifts.
- Although are not part of the definition, vitamins and Trace elements are also affected in re-feeding syndrome and need intense replacement.

Pathogenesis of Re-Feeding Syndrome

- Starvation causes adaptive reductions in cellular activity and organ function, accompanied by electrolyte and micronutrient depletion.
- Insulin concentrations decrease and glucagon levels rise, resulting in gluconeogenesis and the breakdown of protein and lipid.
- Free fatty acids and ketone bodies replace glucose as the major energy source.
- Re-feeding (whether it's oral, enteral or parenteral nutrition) triggers a switch from fat to carbohydrate metabolism, with consequent insulin release, and increased uptake of K+, PO4, Mg and water into cells.

Pathogenesis of Re-Feeding Syndrome

- Consequences include;
  - hypokalemia,
  - hypophosphatemia,
  - hypomagnesemia (possibly causing refractory hypokalemia and hypocalcaemia),
  - altered glucose metabolism,
  - abnormalities in fluid balance, and
  - impaired cardiac, renal and liver function.
- The serum concentrations of electrolytes can appear normal in the starved state, due to alterations in renal excretion rates.
  - monitor electrolyte levels in the early stages of feeding, as this is when biochemical shifts will occur.

Consequences of Altered Electrolytes in Re-Feeding Syndrome

	Cardiac	Respiratory	Hepatic	Renal	GI	Neuro-muscular	Hematologic
Low PO_4	Altered myocardial function Arrhythmia Congestive heart failure	Acute ventilatory failure	Liver dysfunction			Lethargy Weakness Seizures Confusion and/or Coma Paralysis Rhabdomyolysis	Hemolytic anemia WBC dysfunction Thrombocytopenia Haemorrhage Red Cell 2, 3 diphosphoglycerate deficiency
Low K	Arrhythmia Cardiac Arrest	Respiratory depression	Exacerbation of hepatic encephalopathy	Decreased urinary concentrating ability Polyuria and Polydipsia Decreased GFR	Constipation Illeus	Paralysis Rhabdomyolysis Weakness	
Low Mg	Arrhythmia Tachycardia	Respiratory depression			Abdo pain Anorexia Diarrhea Constipation	Ataxia Confusion Muscle tremors Weakness Tetany	

Patients at Risk for Re-Feeding Syndrome
NICE Criteria 2006

- Extremely High Risk:
  - BMI < 14 k/m^2
  - Negligible intake > 15 days.
- High Risk:
  - One or more of the following:
    - BMI < 16 kg/m^2
    - Unintentional weight loss > 15% over last 6 months.
    - Little or no nutritional intake for > 10 days.
    - Low K, PO_4, or Mg before feeding.
  - Two or more of the following:
    - BMI < 18.5 kg/m^2
    - Unintentional weight loss > 10% over last 6 months.
    - Little or no nutritional intake for > 5 days.
    - History of alcohol abuse, or Use of the following drugs: insulin, chemotherapy, diuretics, or antacids with Mg or Al.

Macronutrients, Vitamins, and Micronutrients in "High Risk" Refeeding Syndrome

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- Total Energy and Composition:
  - Start with 10 kcal/kg/d and increase by 5 kcal/kg/d q 2-3 days until intake calorie-goal is reached, monitoring symptoms and laboratory.
  - Ratio: 50-60% carbohydrates, 15-25% fat, 20-30% protein.
- Water: total initial volume (IV + PO) </= 30 mL/kg/d.
- Vitamins: At least for 10 days
  - Thiamine: 300-500 mg IV before feeding; then 100 mg/d
  - B complex: Pyridoxine (B_6) 1.7 mg/d, vitamin B_{12} 2.4 mcg/d, Folic Acid 400-1000 mg/d (can be done with B Complex 1 tablet TID)
  - Multivitamins with Minerals daily.
- Micronutrients:
  - Selenium: load with 100-400 mcg; then 20-70 mcg/d
  - Zinc: load with 30 mg/d; maintain 2.5-5 mg/d.
  - Iron: 10-15 mg/day

Prophylactic Electrolyte Replacement

- If Serum K is normal, give:
  - KCl, usually 2-4 mEq/kg daily.
- If serum Mg is normal, give:
  - Mg Oxide, usually 0.4 mM/kg/d
    - 100 mg of Mg Oxide gives 2.47 mM of Mg.
- If serum Phospate is normal, give:
  - K or Na Phosphate usually 0.3-0.6 mM/kg/day
    - 500 mg “K-Phos Original” gives 3.6 mM of phosphate, and 3.6 mEq of K;
    - 250 mg of “K-Phos Neutral” gives 8 mM Phosphate, 1.1 mEq K, and 13 mEq of Na)

Therapeutic Electrolyte Replacement in "High Risk" Refeeding Syndrome

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- Sodium: Correct hypovolemia with 0.9% NaCl but avoid hypervolemia that may facilitate CHF. Then keep Na intake low to minimize volume overload.
- Phosphate Replacement
  - Mild (2.3-3 mg/dL or 0.75-1 mM/L) = 0.32 mM/kg/d PO or IV of Kphos, or 32 mM PO.
  - Moderate (1.6-2.2 mg/dL or 0.5-0.74 mM/L) = 0.64 mM/kg/d IV of KPhos or 32 mM PO.
  - Severe (< 1.6 mg/dL or < 0.5 mM/L) = 1 mM/kg/d IV Kphos (max 50 mM over 24h), checking serum P at 12 hour intervals.
- Potassium Replacement
  - Asymptomatic or mild to moderate: 1-4 mEq/kg/d of PO KCl.
  - Symptomatic or severe hypoK (2.5-2.9 mM/L): may require IV 40 mM over 8 h, with close monitoring. Consider EKG monitoring during 1st week.
- Magnesium Replacement
  - Mild to moderate (1.2-1.7 mg/dL or 0.5-0.7 mM/L) = 10-15 mM/day as Mg Oxide
  - Severe (< 1.2 mg/dL or < 0.5 mM/L) =
    - Asymptomatic give 15 mM/d Mg Oxide.
    - Symptomatic give 25 mM Mg sulfate IV over 6 h and reassess q 8-12 hours; repeat if needed (up to 50 mM/d)