KEY FACTS IN CLINICAL NUTRITION

SECOND EDITION

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INDICATIONS FOR NUTRITION SUPPORT

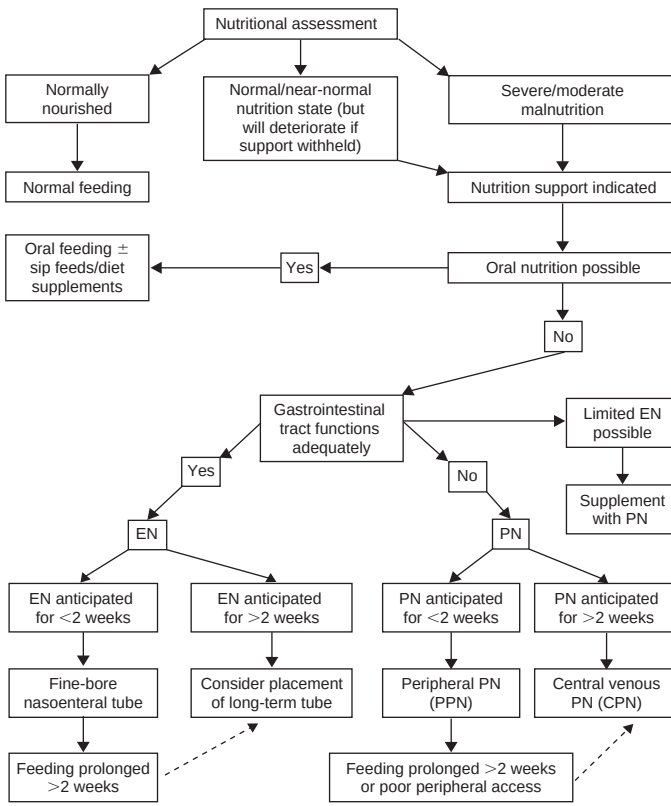
- Up to 50% of hospital patients on admission can have clinical, haematological, biochemical or anthropometric evidence of protein energy malnutrition (PEM) caused by reduced intake of nutrient substrates. This worsens if untreated during stay in hospital and patients can continue to lose weight after discharge from hospital
- >10% body weight loss is associated with increased morbidity including:
  - chest infection
  - wound infection
  - wound breakdown/delayed healing
  - development of pressure areas
  - bacteraemia/septicaemia
  - Prolonged hospital stay
  - Increased incidence of readmission to hospital
  - Increased mortality

PATIENTS REQUIRING NUTRITION SUPPORT*

- Severely malnourished (with marked weight loss and muscle wasting)
- Moderately malnourished (reduced dietary intake in previous month; nutritional parameters low/low-normal)
- Normal/near-normal nutrition status (but at risk of developing PEM due to underlying disease or illness or trauma in absence of nutrition support)

* Hospital and community patients should have their nutrition status reviewed regularly. If nutrition status is sub-optimal there should be an early decision on what type of nutrition intervention is appropriate. If concurrent disease and illness prevent an optimal nutrition state being reached, then the aim of nutrition support is to minimize nutritional depletion

SUMMARY FOR NUTRITION SUPPORT



GENERAL HISTORY

- In addition to normal history relevant to presenting complaint a history of nutrition background must be taken: ask and comment about patient's nutrition status, specifically including: normal weight; weight change (from usual body weight, change in clothes size); activity and fatigue; appetite; fluid losses (e.g. diarrhoea); vomiting; duration of symptoms
- Other factors may also affect nutrition status including: pregnancy, food allergy/intolerance, chronic diarrhoea/malabsorption, drug-nutrient interaction, alcohol abuse, poor dentition, physical disability, poverty

DIETARY ASSESSMENT

- Should be standardised according to local practice
- Can be undertaken in the following ways:

Weighed dietary record (actual)

- Actual consumption (recorded at time of eating)
- Weighing scales accurate to 1 g, are required (these should be regularly calibrated). Subject must weigh all foods and drink consumed in a specific time period
- Record recipes from composite dishes, brand names and foods consumed away from home
- Disadvantages: patients must be cooperative, numerate, literate, motivated

Dietary history (recall)

- Recall of diet (in recent or distant past)
- Estimate food intake over long time period using interview technique
- Record actual intake, usual portion size (using household measures), frequency of consumption of specific foods, general information on eating pattern (during and between meals)
- Disadvantages: time consuming, prone to inaccuracy, patients rarely able to accurately recall intake, interviewer may introduce bias, not suitable for patient with memory impairment

24-hour recall

- Alternative to dietary history; less time consuming but lacks precision
- Rough estimate of type and quantity of food consumed and approximate meal pattern
- Adequate for advising on dietary modification

EXAMINATION

- In addition to routine examination, look for and specifically record:

muscle wasting*	gingivitis
loss of muscle power	nail abnormality
loss of fat stores	glossitis
peripheral oedema	paraesthesia
skin rashes	neuropathy
angular stomatitis	

* Around scapula, temporalis, interossei, intercostals, as well as bulky power muscles

INVESTIGATIONS

- Haemato logical indices: anaemia (type), Fe, folate, vitamin B_{12} (see Appendix I)
- Biochemical: serum K^+, Na^+, PO_4, serum albumin (limited use as nutritional parameter), thyroxine-binding prealbumin, transferrin, retinol-binding protein, C-reactive protein, nitrogen balance (see Appendix I)
- Anthropometry (relatively insensitive; may fail to detect changes in nutrition status over short time periods, see Appendix III): weight[a], height, body mass index, mid-arm circumference (MAC)[b], triceps skinfold (TSF)[c,e] which must be taken directly over the muscle, mid-arm muscle circumference (MAMC)[d,e]; techniques must be standardised to avoid inter observer error; scales and calipers must be regularly caliberated
- Other methods such as dynamometry (e.g. hand grip strength) and bioelectric impedance have been used in predominantly research settings, but are increasingly used as relatively sensitive indicators of changing nutrition status in clinical practice
- Determine BMI[f] [BMI = wt (kg)/ht^2 (m)]

[a] Weigh in light clothing, after emptying bladder and before meal; note if oedema or ascites present; if unable to weigh patient, use recorded weight history or ask a relative
[b] Locate mid-point of upper arm – between acromion and olecranon tip – average of three measurements with inelastic tape measure around arm
[c] Use precision calipers – Harpenden®, Holtain & Lange® – arm hung loosely by side; grasp vertical fold of skin and fat 1cm above the mid-point using thumb and forefinger; apply caliper at 90° at the mid-point; average of three measurements
[d] MAMC = MAC – (0.314 × TSF)
[e] Other suitable skinfold sites include biceps, subscapular, and suprailiac
[f] BMI ⩽ 19 – undernutrition; BMI ⩽ 25 – eccessive weight

ROLE, SYMPTOMS AND SIGNS OF DEFICIENCY

Vitamin	Role	Potential symptoms and signs of deficiency
A	Growth, development and differentiation of tissues	Poor dark adaptation; xerophthalmia
D	Absorption of calcium; macrophage differentiation	Osteomalacia; rickets
E	Antioxidant	Neuropathy; myopathy; infant haemolytic anaemia
K	Control of coagulation	Bleeding disorders
B_1 (thiamin)	Decarboxylation in fat, carbohydrate and ethanol	Beriberi – polyneuritis, Wernicke's encephalopathy, cardiac failure, weakness
B_2 (riboflavin)	Oxidative metabolism	Angular stomatitis; cheilosis; corneal vascularization; glossitis; seborrhoeic dermatitis
B_6 (pyridoxine)	Amino acid transamination	Infant anaemia; cheilosis; glossitis; peripheral neuritis
B_{12}	Folate coenzyme recycling; valine metabolism	Megaloblastic anaemia; peripheral neuritis; subacute combined degeneration of the cord; optic atrophy; dementia
C (ascorbic acid)	Antioxidant; iron absorption	Scurvy; poor wound healing
Niacin	NAD and NADP for oxidative metabolism	Pellagra – dementia, diarrhoea, dermatitis, glossitis
Folic acid	Transfer of single carbon units; purine/pyrimidine metabolism	Megaloblastic anaemia; glossitis; peripheral neuropathy; dementia; neural tube defects in pregnancy
Biotin	Carboxylase reactions (lipogenesis/gluconeogenesis)	Dermatitis; alopecia; grey pallor; depression; lassitude; myalgia; paraesthesia

ROLE, SYMPTOMS AND SIGNS OF DEFICIENCY *continued*

Element	Role	Potential symptoms and signs of deficiency
Cobalt	Organic complex (insulin, lipoprotein metabolism); gene expression	Weight loss; glucose intolerance; peripheral neuropathy
Copper	Cytochrome oxidase; superoxide dismutase; neuroactive amines	Microcytic, hypochromic anaemia; neutropenia; cardiac arrythmia; hair depigmentation; (in children – skeletal demineralization, growth retardation, CNS abnormalities, hypotonia)
Fluoride	Bone mineralization	Possible dental caries
Iodine	T_4 and T_3 cellular metabolism	Goitre; adults – hypothyroidism; infants – cretinism
Iron	Haemoglobin/myoglobin/cytochrome metabolism	Anaemia; pallor; fatigue; dyspnoea; tachycardia; paraesthesia; malaise; painful tongue
Manganese	Mitochondrial superoxide dismutase, arginase hydrolase and kinase co-factors	Lipid metabolism abnormalities; hair changes; anaemia
Molybdenum	Xanthine oxidase (DNA metabolism); sulphite oxidase (sulphur metabolism)	Headache; visual disturbance; vomiting; tachycardia; tachypnoea; mental change; coma
Selenium	Glutathione peroxidase (antioxidant); thyroxine deiodinase	Myositis; cardiomyopathy; macrocytosis; pseudoalbinism
Zinc	Metalloenzyme formation; RNA conformation; membrane stabilization; pre-secretory insulin granules	Growth retardation; alopecia; skin lesions; hypogonadism; hypospermia; diarrhoea; visual and taste disturbance; mental changes; impaired wound healing; immunosuppression

- All values quoted are the Estimated Average Requirements for that nutrient; energy requirements quoted assume a low physical activity
- Methods for calculating requirements:
  Standard tables (easy to use, accuracy limited)
  Formula derived (relies on body weight, time consuming)
  Indirect calorimetry (metabolic cart, accurate, cost limits availability)

ENERGY REQUIREMENTS

	Males		Females	
Age (years)	MJ/d	kcal/d	MJ/d	kcal/d
19–49	10.60	2550	8.10	1940
50–59	10.60	2550	8.00	1900
60–64	9.93	2380	7.99	1900
65–75	9.71	2330	7.96	1900
75+	8.77	2100	7.61	1810

PROTEIN AND VITAMIN REQUIREMENTS

Nutrient	Units	Males	Females
Protein 19–49 years	g/d	44.40	36.00
Protein 50+ years	g/d	42.60	37.20
Vitamin A	μg/d*	500.00	400.00
Thiamin (B_1)	mg**	0.40	0.40
Riboflavin (B_2)	mg/d	1.00	0.90
Niacin	mg**	5.50	5.50
Vitamin B_6	μg†	13.00	13.00
Vitamin B_{12}	μg/d	1.25	1.25
Folate	μg/d	150.00	150.00
Vitamin C	mg/d	25.00	25.00

* μg retinol equivalent/d; ** mg/1000 kcal; † μg/g protein
Source: HMSO, London 1991, reproduced with permission

MINERAL REQUIREMENTS

Mineral	Atomic weight	Units	Male	Female
Calcium	40	mg/d	700	700
Magnesium	24	mg/d	300	270
Iron	56	mg/d	8.7	14.8*
Zinc	65	mg/d	9.5	7.0
Sodium	23	mg/d	1600	1600
Potassium	39	mg/d	3500	3500
Copper	63.5	mg/d	1.2	1.2
Iodine	127	μg/d	140	140
Selenium	79	μg/d	75	60
Molybdenum	96	μg/d	50–400**	50–400
Manganese	55	mg/d	>1.4**	>1.4
Chromium	53	μg/d	>25**	>25

Values quoted are the Reference Nutrient Intake (RNI) – adequate for 97% of population
* After the menopause the RNI will fall to 8.7 mg/d
** No RNI available, values quoted (safe intake) are considered adequate for the majority of the population

SUMMARY OF TYPICAL ADULT REQUIREMENTS (24 h)

		Metabolic state	
Nutrient	Normal	Intermediate	Hypermetabolic
Protein (g/kg)	1.0	1.3–1.9	2.0–3.0
Nitrogen (g/kg)	0.17	0.2–0.3	0.3–0.45
Energy (kcal/kg)	25–35	35–40	40–60
(kJ)	(105–150)	(150–170)	(170–250)
Fluid (ml/kg)	30–35	30–35	30–35
Sodium (mmol/kg)	1.0*	1.0	1.0
Potassium (mmol/gN)	5.0	5.0	7.0
Phosphate (mmol/d)	20	20–30	⩽50

* Min. 50 per day
Note: always make provision for non-renal loss (e.g. diarrhoea, fistulas) and pyrexia (for each 1° rise in temperature add 0.6 g N, 10% energy, 30 mmol sodium and fluid as clinically indicated)

CONVERSION FACTORS

Protein	1 g nitrogen	= 6.25 g protein
Energy	1 kcal	= 4.184 kJ
Vitamin A	1 IU	= 0.3 μg retinol; 0.6 μg β-carotene
Vitamin D	1 μg	= 40 IU; 1 IU = 0.025 μg
Vitamin E	1 mg d-α-tocopherol	= 1.49 IU

To convert milligrams to millimoles:
divide mg substance by relative atomic mass (At Wt)

Calcium correction:
measured calcium (mmol/l) + (40-albumin (g/l)/40)

PHYSIOLOGICAL FUEL VALUES AND RESPIRATORY QUOTIENT (RQ)

Fuel	kcal/g	RQ
Carbohydrate	4	1.0
Fat	9	0.7
Protein	4	0.81
Alcohol	7	0.67

SCHOFIELD EQUATION

Age (years)	Male	Female
15–18	BMR = 17.6 × weight (kg) + 656	BMR = 13.3 × weight (kg) + 690
18–30	BMR = 15.0 × weight (kg) + 690	BMR = 14.8 × weight (kg) + 485
30–60	BMR = 11.4 × weight (kg) + 870	BMR = 8.1 × weight (kg) + 842
>60	BMR = 11.7 × weight (kg) + 585	BMR = 9.0 × weight (kg) + 656

Source: Schofield 1985 equations for estimating basal metabolic rate (BMR). Hum Nutr: Clin Nutr 39C: 5–41

HARRIS–BENEDICT EQUATION

Men	Women
EER (kcal) = 66.5 +13.75 W + 5.00 H – 6.77A EER (kJ) = 278 + 57.5 W + 20.93 H – 28.35 A	EER (kcal) = 655.1 + 9.56 W + 1.85 H – 4.67 A EER (kJ) = 2741 + 40.0 W + 7.74 H – 19.56 A

W = weight (kg); H = height (cm); A = age (years)

DETERMINATION OF ENERGY REQUIREMENTS

To BMR (A), determined for normal adult from Schofield equation	A
add stress factor* (B)	A + B
adjust for 24-h energy expenditure (C) (+20% immobile; +30% bed bound but mobile; +40% mobile in ward)	A + B + C
add 10% for specific dynamic action of food (D)	A + B + C + D
add temperature factor – 10% for each 1° rise in temperature (E)	A + B + C + D + E
add up to 600 kcal/d if increase in weight is required, or reduce energy intake if weight loss is required (not applicable to critically ill patients) (F)	A + B + C + D + E + F

*Severe sepsis = 10–30%; extensive surgery = 10–30%; fractures/trauma = 10–30%; burns/wounds = 50–150%; RDS = 20%

DIETARY MODIFICATION

The nutrient needs of a patient may require advice and support from a multi-professional team including dietitian, nurses and speech and language therapists to address relevant areas

A deteriorating nutrition state is frequently associated with:

- Decreased oral intake, due to nausea/vomiting, an inability to eat or swallow (e.g. stroke, coma, oral surgery, oesophageal obstruction/ infection)
- Hospitalization may precipitate a decreased intake due to the strange environment, anxiety, unusual foods and mealtimes and being kept nil-by-mouth for investigations
- Increased requirements (e.g. in impaired digestion & absorption, burns, fractures, fever, surgery)
- Malnutrition must be prevented by early nutrition intervention either with supplements to a normal or modified diet or complete enteral feeding
- Drug therapy, e.g. nausea and vomiting with cytotoxins, opiates, bromocriptines, anorexia with some anti-depressants, oral hypoglycaemics, anti-arrhythmics and anti-hypertensives

Oral intake may be improved by altering diet:

- Soft or pureed for chewing and swallowing difficulties – but nutritional adequacy of the modified diet must be calculated and maintained
- Fortified 'normal' foods
  If a 'normal' or modified diet is not providing adequate nutrition then the food needs to be fortified: add butter, milk, egg, milk powder to food; alternatively, special products manufactured for this purpose can be added to the food but regional and national food safety regulations may influence these additions
- Supplements
  If adequate nutrition is not provided by either of the above, or only liquid nutrition is tolerated then a commercially prepared supplement drink should be used
- Nasogastric feeds
  May be given as a supplement to any of the above or as the sole source of nutrition – commercially prepared feeds and supplements are available for most patient groups

READY-TO-USE ENTERAL FORMULAS

Feed	Comments/features
• Whole protein (polymeric)	
Standard	Approximately 100 kcal, 4 g protein/100 ml; suitable for most nasoenteral feeding
High energy	1.5–2.0 kcal/ml; for high calorie requirements or volume restriction
High fat feed	May benefit patients difficult to wean off a ventilator
Fibre containing	To discuss with dietitians
High protein	Increased nitrogen requirements
Low protein/low mineral	Renal impairment
Low sodium	Patients with ascites/hypertension
• Non-whole proteins	
Nitrogen as free amino acids or peptides	May be used in Crohn's disease, short bowel and other severe malabsorption states, elimination diets
• Disease-specific formulas	e.g. for critically ill, respiratory, liver (need to discuss with dietitians)

Note: Fat as MCT used for malabsorption states/steatorrhoea; introduce with care to avoid cramp/diarrhoea

SUPPLEMENTS AVAILABLE FOR ENTERAL ROUTE

Supplement	Comments/features
• Liquid	Nutritionally complete, suitable sip feed for most patients; available as 1.0 or 1.5 kcal/ml
• Powder	Indications as for liquid; are not nutritionally complete
• Carbohydrate (powder or liquid)	Add to food or drinks as an energy supplement
• Fat emulsion (LCT or MCT)	Add to food, or as a component of a supplement drink, as an energy supplement
• Powdered milk and soya	Add to food to supplement the protein content of the diet; component of a supplement drink

CONTRAINDICATIONS TO ENTERAL NUTRITION (EN)

- The main contraindications to EN are:
  - An inability to meet nutrient needs via the enteral route alone
  - Complex fluid balance problems (when clinical management may be impaired because of fluid sequestration within gut lumen)
  - Intestinal obstruction
  - Paralytic ileus
- If there is partial gastrointestinal function, PN should be used and supplemented with EN

Absence of bowel sounds in a ventilated patient with no other signs of ileus is not a contraindication to enteral nutrition support. Gastric residual volumes ⩾200 ml may indicate potential problems – but would not necessary preclude post-pyloric feeding

FACTORS TO CONSIDER FOR EN

Access route	Monitoring
Enteral formula	Complications
Delivery techniques	Patient preference (where applicable)

Access routes

- Short-term feeding (anticipated for <2 weeks)
  - Fine-bore nasoenteral tubes (FBT)
    - Nasogastric
    - Nasoduodenal
    - Nasojejunal
  - Dual function (gastric aspiration/jejunal feeding tubes)
- Long-term feeding (anticipated for >2–4 weeks)
  - Gastrostomy
    - Surgical
    - Percutaneous endoscopic (PEG)
    - Fluoroscopic percutaneous
    - Laparoscopic
    - Button ostomies (for cosmesis)
  - Duodenostomy
    - Percutaneous endoscopic
  - Jejunostomy
    - Surgical
    - Percutaneous endoscopic
    - Jejunal tubes through PEG
    - Needle catheter (NCJ)
    - Cuffed tube

FINE-BORE NASOENTERAL TUBES (FBTs)

- Preferable to the wide-bore PVC Ryle's or Levine tubes; much less likely to cause: nasopharyngeal discomfort, nasal erosions, oesophagitis, oesophageal ulceration and otitis media
- Most have wire stiffening stylets – place tubes using standard protocols
- Main complications: malposition (at insertion), displacement (subsequently) and occlusion (subsequently), inadvertent removal by patient
- Malposition into trachea or bronchus may cause inadvertent intra-pulmonary administration of enteral feed; oesophageal or pulmonary perforation may occur
- Confirm tube position (before starting feeding) by: air injection through the tube and auscultation in the epigastrium and aspiration of gastric contents and confirmation of acid pH (if patient is alert and orientated); or by X-ray fluoroscopy if these methods fail or patient has altered consciousness, or impaired gag reflex or deglutition

Post-pyloric feeding

- May assist patient groups with increased risk of gastric regurgitation and pulmonary aspiration of gastric contents (due to either gastroparesis or stasis and/or recumbency): diabetes with neuropathy, hypothyroidism, neuromotor deglutition disorders, neurosurgical patients, post-abdominal surgery, ventilated patients
- For such patients, use of long FBT's to deliver EN into the duodenum or jejunum is appropriate
- Placement of nasoduodenal/jejunal tubes is best achieved using fluoroscopic endoscopic techniques
- In the surgical patient placement of tubes can be done during the operation (e.g. placement of NCJs in trauma patients)
- In surgical and critically ill patients use of dual lumen tubes (designed for simultaneous gastric aspiration and jejunal administration of feed) may be considered to allow early commencement of EN

PERCUTANEOUS GASTROSTOMIES

- Surgically placed gastrostomies (unless concurrently at laparotomy) are rarely used now
- Percutaneous placement – either endoscopic or radiologic normally under local anaesthesia is technique of choice
- Prior to placement ensure site is appropriate
- Site of placement should be away from skin folds
- Contraindications include ascites and gross obesity
- Complications* include:
  - Local wound infection
  - Granulating tissue
  - Necrotizing fasciitis
  - Pneumoperitoneum
  - Intra-abdominal abscesses
  - Tube displacement
  - Bleeding
  - Bowel perforation
- Complication rate should be no more than 1–2%
- If displaced or potentially misplaced confirm placement radiologically

SKIN LEVEL GASTROSTOMIES/BUTTON OSTOMIES

- Increasingly used in long-term enterally fed patients as they are more cosmetically acceptable

NEEDLE CATHETER JEJUNOSTOMIES (NCJ)

- Can be placed surgically in four clinical situations:
  - If patient is malnourished at the time of surgery
  - During major upper gastrointestinal surgery
  - If post-surgery chemo/radiotherapy is planned
  - At laparotomy for major abdominal trauma
- Placement of an NCJ adds a few minutes to surgery; if not required it may be easily removed
- Main complications*:
  - Displacement
  - Intra-peritoneal leakage
  - Small bowel perforation

* These are generally avoided if proper insertion protocols (including prophylactic antibiotics according to local practice) and commercially produced gastrostomy kits are used

DELIVERY TECHNIQUES

Constant infusion

- Should be used whenever possible, preferably with a pump
- Enteral formula requirement delivered over 20–22 h to allow time for catch up if delays

Intermittent infusions

- Enteral formula delivered over 8–12 h (or shorter regimen e.g. 3 h on and 2 h off) preferably with a pump
- Convenient and safe, and is widely used by patients on home EN – patient's preference often dictates technique used
- Can be administered overnight (or shorter periods) allowing patient more freedom during the day
- Physiological benefit to regimens with a few hours break

Starter regimens

- Full strength diets should be used from the beginning of EN
- Infusion rate may be rapidly increased to desired rate
- Use of diluted diets when commencing EN should be avoided
- Diluted diets delay onset of positive nitrogen balance and increase incidence of diarrhoea, nausea, cramps, bloating and abdominal discomfort

Bolus feeding

- 100–400 ml over 10–30 min several times daily
- Increases patients mobility; is convenient; needs less equipment
- But can increase the incidence of diarrhoea, cramps, nausea, bloating and abdominal discomfort

Recumbency/semirecumbency

- Raise head of bed so patient at angle of 30–45° during infusion; may help reduce the risk of regurgitation and pulmonary aspiration of diet

GI function impaired

- Consider use of supplemental PN (peripheral or central) to achieve requirements

CONCURRENT DRUG ADMINISTRATION

- Check with dietitian/pharmacist to assess safety and efficacy of administered drug in enteral feed tubes. Some drugs will interact with feed (e.g. anti-epileptic, anti-hypertensive drugs)

Gastric residual volumes

- Initially aspirate the enteral tube 4 hourly to record gastric residual volumes (GRV) to determine whether normal stomach emptying is present
- If GRV >200 ml further investigation (±X-ray) is appropriate, and the rate of feed should be reduced in the interim; prokinetic agents can be of use

Closed sterile diet containers

- Minimize handling of delivery systems and connectors to reduce bacterial contamination risks
- EN is a risk factor for infection in certain high-risk patient groups such as those with extensive burns, AIDS/HIV, the critically ill, those on chemotherapy and neonates
- Enteral feed can be contaminated via a number of endogenous and exogenous routes. Endogenous: diet components, diet kitchen, mixing utensils, during feed transfer to reservoir, sub-optimal storage, handlers, war/home environment, administration sets. Exogenous: patient (retrograde contamination from gastrointestinal tract via enteral tube)
- Use of commercial sterile closed diet containers is recommended for all high-risk groups
- Interruption of a feed infusion for 4 h/d will allow gastric pH to drop below 2.5, thereby exerting an additional antibacterial effect

Diet reservoirs

- Frequent changing or refilling of smaller volume reservoirs reduces the amount of enteral diet delivered to the patient over 24 h and increases contamination risks
- Larger volume (>1 l) sterile pre-filled reservoirs or containers should be used whenever possible to minimise handling

ENTERAL NUTRITION-RELATED COMPLICATIONS

Complication	Cause	How to avoid/prevent/cure/minimize complications
Tube malposition	No cause (5% of insertions)	Observe insertion protocol and confirm placement before starting infusion. Check placement if has been displaced (IXRAY)
Tube displacement	Accident; failure of fixation	Regular observation and replacement of fixation device/tape
Tube occlusion	Viscous diet/failure to flush tube; feed stasis; inappropriate medication (e.g. crushed tablets) administered through tube	Mark tube at nostril with indelible pen and flush tube regularly with H_2O; if occluded flush water and use pancreatic enzyme if occlusion persists, if no success, replace tube possibly with wide lumen (do not reinsert stylet)
Diarrhoea	Concurrent antibiotics; bolus injective feeding; too rapid infusion rate; starter regimen; possibly hypoalbuminaemia	Treat symptomatically (e.g. add loperamide, codeine phosphate); review drug chart and diet administration regimen; do not immediately stop feeding Send stool specimen for microbiological analysis
Cramps, nausea, bloating	Bolus feeding; too rapid infusion rate; enteral feed intolerance (rare); central causes for nausea/vomiting	Review diet administration regimen and modify (e.g. reduce infusion rate); check gastric residual volumes; consider post-pyloric feeding; antiemetic/prokinetic drugs)

ENTERAL NUTRITION-RELATED COMPLICATIONS *continued*

Complication	Cause	How to avoid/prevent/cure/minimize complications
Constipation	Dehydration; recumbency; enteral diet	Review diet regimen; mobilize; suppositories may assist; avoid dehydration
Regurgitation, vomiting pulmonary aspiration	Gastroparesis; gastric stasis, recumbency; tube misplacement	Check tube position (pH estimation or X-ray); elevated head of bed to 30–45°; prokinetic drugs; consider post-pyloric feeding
Destabilization of drug regimens (e.g. epilepsy, asthma, anticoagulation)	Drug interaction with enteral diet (e.g. warfarin, phenytoin, theophylline)	Assess drug levels; titrate dose; monitor closely; check administered correctly
Nosocomial infection (e.g. bacteraemia, speticaemia, pneumonia)	Enteral diet contamination; other patient derived bacteral contamination	For all patients use commercial, sterile closed diet containers; sterile handling; change giving sets every 24 h; hang-time (of diet) must never exceed 24 h; if no closed system and reconstitution required use sterile water; store at 4°C before use
Metabolic abnormalities (e.g. hyperglycaemia, hyperkalaemia, hypophosphataemia, hypomagnesaemia)	Refeeding and concurrent disease or illness	Regular monitoring in the first 10 d of feeding (particularly in those with concurrent disease or illness and the severely malnourished); adjust diet or supplement intravenously as appropriate

INDICATIONS FOR PARENTERAL NUTRITION (PN)

- All nutrition requirements can be given solely via the parenteral (intravenous) route
- Parenteral nutrition, PN, is indicated for any patient with acute or chronic, temporary or permanent intestinal failure or whose nutrition needs cannot be met by the enteral route
- Common patients group requiring PN are:
  - Short bowel syndrome (after intestinal resection)
  - Radiation enteritis
  - Acute pancreatitis
  - Prolonged ileus
  - High intestinal fistulae
  - Severe mucositis
  - Partial gastrointestinal function

FACTORS TO CONSIDER FOR PN

- Access
- Nutrient substrates
- Infusion techniques
- Monitoring
- Complications

PERIPHERAL PARENTERAL NUTRITION

- PPN should be considered for any patient with a non-functioning or partially functioning gastrointestinal tract requiring feeding for <10–14 d, (most patients receive PN for <14 d)
- Peripheral vein thrombophlebitis (PVT) is minimized by avoiding excess glucose levels, use of lipid emulsions; use of All-in-One (AIO) admixture
- Common methods which can be used (singly, but preferably in combination) to minimize PVT and permit PPN:
  - Strict protocol for insertion, fixation and care (see below)
  - Use fine-bore IV cannulas (polyurethane or silicone elastomer)
  - Use largest forearm or antecubital vein available
  - AIO solutions manipulated to minimize osmolality (e.g. 50% of energy source from lipid emulsion)
  - Transdermal glyceryl trinitrate (5mg patches applied daily to skin adjacent to IV cannula)
  - Nutrition Support (or IV) Teams monitoring patient
- IV cannulas must be removed at first sign of PVT (i.e. local erythema, swelling, hardness, pain or extravasation)