

Nutrition in Intensive Care



Six simple questions

- Why do we feed ICU patients?
- Which patients should we feed?
- When should we start to feed them?
- Which route should we feed by?
- How much feed should we give?
- What should the feed contain?



Why feed ICU patients?

- catabolism of critical illness causes malnutrition
- malnutrition closely associated with poor outcomes
- many ICU patients are malnourished on admission

Aims of feeding ICU patients

- treat existing malnutrition
- minimise (but not prevent) the wasting of lean body mass that accompanies critical illness

Nutritional assessment

- important to identify existing malnutrition
- clinical evaluation is better than tests
- history
 - weight loss, poor diet, reduced function
- examination
 - loss of subcutaneous fat, muscle wasting, peripheral oedema, ascites

Which patients should we feed?

- **which patients can safely be left to resume feeding themselves?**
 - 14 days' starvation - dangerous depletion of lean body mass
 - mortality rises in ICU patients with a second week of severe under-feeding
 - 5 days without feed increases infections but not mortality
 - one view is therefore that 5-7 days is the limit

Which patients should we feed?

- **however**
 - ACCEPT study fed all patients not likely to eat within 24 hours
 - one meta-analysis suggests reduced infections if patients are fed within 48 hours
 - one meta-analysis of early TPN versus delayed EN found reduced mortality with early feeding

Which patients should we feed?

- all malnourished patients
- all patients who are unlikely to regain normal oral intake within either 2 or 5-7 days depending on your view

When should we start to feed?

- early feeding usually defined as starting within the first 24 hours of admission
- reduced infections if patients are fed within 24 hours
- meta-analysis of early TPN versus delayed EN found reduced mortality with early feeding

When should we start to feed?

- surgical issues
 - gastric, duodenal or high small bowel anastomoses
 - critical mesenteric ischaemia

When should we start to feed?

- without undue delay once the patient is stable
- this will usually be within 24 hours of ICU admission

What route should we feed by?

- enteral feeding is claimed to be superior because
 - it prevents gut mucosal atrophy
 - it reduces bacterial translocation and multi-organ failure
 - lipid contained in TPN appears to be immuno-suppressive

Is enteral feeding really better?

- mucosal atrophy occurs far less in humans
- TPN is associated with increased gut permeability
- bacterial translocation does occur in humans and may be associated with infections
- increased gut permeability never shown to cause translocation
- translocation has never been shown to be associated with multi-organ failure
- enteral nutrition has never been shown to prevent translocation

Outcome evidence

- does EN reduce infections?
 - pancreatitis - probably
 - abdominal trauma - probably (2 trials of 3)
 - head injury - evenly balanced
 - other conditions – no clear conclusion
 - Lipman reviewed 31 trials and found no consistent effect
 - meta-analysis by Heyland et al found reduced infections
- EN is definitely a risk factor for VAP

What route should we feed by?

- enteral feeding is
 - cheaper
 - easier
 - and therefore preferable in most cases
- parenteral feeding is obviously necessary in some

What route should we feed by?

- EN preferred for majority on pragmatic grounds alone
- TPN obviously necessary for some
- if there is serious doubt that EN can be established in a reasonable time (ACCEPT study used 1 day; others would use 2 or 5 or 7...)
 - commence TPN
 - maintain at least minimal EN
 - keep trying to establish EN

Enteral feeding

- underfeeding is a serious problem
- NJ tubes
 - probably do not reduce VAP
 - probably increase proportion of target delivered
- prokinetic agents of unproven efficacy
- PEGs are not advisable in acutely ill patients

Diarrhoea

- use fibre-containing feed
- avoid drugs containing sorbitol and Mg
- exclude and treat
 - *Clostridium difficile* infection
- consider
 - malabsorption (pancreatic enzymes, elemental feed)
 - lactose intolerance (lactose-free feed)
 - using loperamide

TPN - complications

- catheter-related sepsis
 - no benefit from single lumen catheters
- hyperchloraemic metabolic acidosis
- electrolyte imbalance - low Pi, K, Mg
- refeeding syndrome
- rebound hypoglycaemia on cessation
- deficiency of thiamine, vit K, folate

How much feed should we give?

- overfeeding is
 - useless - upper limit to amounts of protein and energy that can be used
 - dangerous
 - hyperglycaemia and increased infection
 - uraemia
 - hypercarbia and failure to wean
 - hyperlipidaemia
 - hepatic steatosis



How much should we feed?

- underfeeding is also associated with malnutrition and worse outcomes

How much feed should we give?

- energy - 25 kCal/kg/day (ACCP)
 - indirect calorimetry
 - gold standard
 - no evidence of benefit
 - shows that other methods are inaccurate, especially as patients wean
 - equations
 - eg Schofield, Harris-Benedict
 - correct for disease, activity

- **Harris-Benedict principle** is a method used to estimate an individual's basal metabolic rate (BMR) and daily kilocalorie requirements

- The Harris–Benedict equations revised by Roza and Shizgal in 1984.^[3]
- Men BMR = $88.362 + (13.397 \times \text{weight in kg}) + (4.799 \times \text{height in cm}) - (5.677 \times \text{age in years})$
- Women BMR = $447.593 + (9.247 \times \text{weight in kg}) + (3.098 \times \text{height in cm}) - (4.330 \times \text{age in years})$

Indirect calorimetry

- **Indirect calorimetry** calculates heat that living organisms produce by measuring either their production of carbon dioxide and nitrogen waste (frequently ammonia in aquatic organisms, or urea in terrestrial ones), or from their consumption of oxygen
- <http://en.wikipedia.org/wiki/Calorimetry>

Current recommendation

- Critical pat. First week

25 kcal/kg/day (105 kJ/kg/day)

- Next weeks in trauma/septic pat.

30 - 35 kcal/kg/day (125-146 kJ/kg/day)

How much feed should we give?

- nitrogen
 - no benefit from measuring nitrogen balance
 - nitrogen 0.15-0.2 g/kg/day
 - protein 1-1.25 g/kg/day
 - severely hypercatabolic patients (eg burns) may receive up to 0.3 g nitrogen/kg/day

What should the feed contain?

- carbohydrate
 - EN: oligo- and polysaccharides
 - PN: concentrated glucose
- lipid
 - EN: long and medium chain triglycerides
 - PN: soya bean oil, glycerol, egg phosphatides
- nitrogen
 - EN: intact proteins
 - PN: crystalline amino acid solutions
- water and electrolytes
- micronutrients

Dose of nutrients for adult 1kg/ day

need	basic	increased	high
water(ml)	30 - 40	40 - 65	65 – 100
energy kJ/kcal	120-150/ 28-35	150-200/ 35 -47	200 -250/ 47 - 60
AMA (g)	0,7	1,1 – 1,8	2,0 – 2,5
Glc (g)	2-3	5	6
lipids (g)	2	3	3-4

Nutrition in acute renal failure

- essentially normal
- CVVHD/F has meant fluid and protein restriction are no longer necessary or appropriate

Nutrition and liver disease

- chronic liver disease
 - **energy** requirement normal
 - **lipolysis** increased so risk of hypertriglyceridaemia
 - **protein** restriction not normally needed, but in chronic encephalopathy intake should be built up from 0.5 g protein/kg/day
 - **BCAA**-enriched feed may permit normal intake in the protein-intolerant
- acute liver failure
 - **gluconeogenesis** impaired, so hypoglycaemia a risk

Nutrition in respiratory failure

- avoid overfeeding at all costs
- energy given as 50% lipid may reduce PaCO₂ and improve weaning, but unproven

Nutrition in acute pancreatitis

- **transpyloric feeding** shown to
 - be safe
 - reduce infection rate
 - probably reduce mortality
- **malabsorption** may require elemental feeds and pancreatic enzyme supplements
- **TPN** no longer standard therapy - however, some patients do not tolerate enteral feeding

What else should the feed contain?

- glutamine?
- selenium?
- immunonutrition?

Glutamine

- primary fuel for enterocytes, lymphocytes and neutrophils; also involved in signal transduction and gene expression
- massive release from skeletal muscle during critical illness
- may then become 'conditionally essential'
- is not contained in most TPN preparations

Enteral glutamine

- reduces villus atrophy in animals and humans
- reduced pneumonia and bacteraemia in two studies - multiple trauma, sepsis
- one much larger study (unselected ICU patients) showed no effect
- difficult to give adequate dose enterally
- probably not worth it

Parenteral glutamine

- Liverpool study in ICU showed reduction in late mortality
- London study of all hospital TPN patients showed no benefit
- French trauma study showed reduced infection but no mortality effect
- German ICU study improved late survival in patients fed for more than 9 days

Parenteral glutamine

- glutamine becomes conditionally essential in critical illness and is not given in standard TPN
- parenteral supplementation appears to be beneficial in patients requiring TPN for many days

Selenium

- regulates free-radical scavenging systems
- low levels common in normals and ICU patients
- several small studies inconclusive but suggest benefit
- one large, flawed recent study showed non-significant mortality benefit
- watch this space...

Immunonutrition

- omega-3 fatty acids
 - produce less inflammatory eicosanoids
- arginine
 - nitric oxide precursor
 - enhances cell-mediated immunity in animals
- nucleotides
 - DNA/RNA precursors
 - deficiency suppresses cell-mediated immunity

Immunonutrition

- few studies in ICU populations
- some found reduced infection in elective surgery
- one unblinded study has shown reduced mortality in unselected ICU patients; benefit in least ill (CCM 2000; 28:643)
- another showed increased mortality on re-analysis which barely failed to reach statistical significance (CCM 1995; 23:436)

Immunonutrition

- first meta-analysis (Ann Surg 1999; 229: 467)
 - no effect on pneumonia
 - reduced other infections and length of hospital stay
 - increased mortality only just missing statistical significance
 - did not censor for death
- second meta-analysis (CCM 1999; 27:2799)
 - reduced infection
 - reduced length of ventilation and hospital stay
 - no effect on mortality

Immunonutrition

- third meta-analysis (JAMA 2001; 286:944)
 - benefit in elective surgery
 - increased mortality in ICU patients with sepsis
- large Italian RCT (ICM 2003; 29:834)
 - compared enteral immunonutrition with TPN
 - stopped early because interim analysis showed increased mortality in septic patients
 - 44.4% vs 14.3%; $p=0.039$

Immunonutrition

- arbitrary doses
- random mixture of agents
- mutually antagonistic effects
- diverse case mix

- individual components need proper evaluation

Why do we feed ICU patients?

- to treat existing malnutrition
- to minimise the wasting of lean body mass that accompanies critical illness

Which patients should we feed?

- all malnourished patients
- all patients who are unlikely to regain normal oral intake within 2 days

When should we start to feed?

- without undue delay once the patient is stable
- within 2 days

What route should we feed by?

- EN preferred for majority on pragmatic grounds alone
- TPN obviously necessary for some
- if there is serious doubt that EN can be established in 2 (or 5, 7...) days
 - commence TPN
 - maintain at least minimal EN
 - keep trying to establish EN

How much feed should we give?

- 25 kCal/kg/day
- equations
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