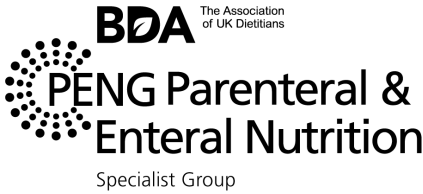

A Pocket Guide To **Clinical Nutrition**

Fifth Edition

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Estimation of protein requirements for adults

Protein requirements for injury and disease

- Maintenance of nitrogen balance depends on past and recent energy intake, metabolic state, physical activity and protein intake. Largest protein losses have been documented in sepsis, major trauma and burns. In these conditions nitrogen balance is almost impossible to achieve in the early catabolic phase post injury (Cerra *et al*. 1987).

- Guidance on the amount of protein that should be provided in nutritional support for patients with disease are based on a review of published guidelines and a summary of the recommendations can be found in **Table 3.9**.

- Where there is no protein requirement guideline available the PENG Requirements Guideline Group, 2018 recommends using **1.0-1.5g protein/kg actual body weight/day**.

- With the exception of Choban (2013) protein requirements for specific BMIs and weight ranges were not discussed in any of the guidelines.

When considering applying the recommendation of a guideline to clinical practice, both the rigour of the development process and the strength of the evidence should be considered. In general, for patients with a BMI 18.5-30kg/m^2, the majority of published guidelines recommend protein intakes between 1.0 to 1.5g/kg actual body weight/day during injury or disease. Therefore, for clinical conditions where there are no published guidelines, a protein intake of 1.0 to 1.5g/kg actual body weight/day should be used (PENG Requirements Guideline Group consensus opinion, 2018). Refer to **Section 2** for **guidance on nitrogen balance**.

Protein requirements in the post injury/ recovery phase

Aim to provide up to 1.9g protein per kg actual body weight/day (0.3g nitrogen/kg) in uncomplicated depletion or the anabolic phase post injury (Elia, 1994). It should be noted that experimentally starved, healthy individuals are able to consume (and utilise) up to 3.75g protein per kg

body weight/day (0.6 g nitrogen/kg) on re-feeding (Keys *et al*. 1950) although it is yet to be determined if this is applicable to patients recovering from acute illness or injury.

Protein requirements in kidney disease, liver disease and critical illness, can be found in **Sections 14**, **15** and **16 respectively.** For these clients, alongside this tool, you must refer to these chapters by purchasing a complete copy of the Pocket Guide To Clinical Nutrition: 5th Edition updated 2018.

Protein requirements at the extremes of body weight (BMI <18.5kg/m² and >30kg/m²)

A protein intake of 1.0 to 1.5g/kg actual body weight/day is likely to result in underfeeding in the underweight and overfeeding in the overweight but none of the published guidelines provide evidence-based recommendations on how to adjust intake other than the recent ASPEN guidelines (Choban *et al*. 2013). Choban *et al*. (2013) recommends high protein hypocaloric feeding but this recommendation is based on low level evidence so should only be used in experienced centres where FM and FFM can be monitored. Current practice in the UK is to reduce estimated protein requirements to 65-75% in obesity and in the absence of evidence-based guidelines this method should continue to be used (**Table 3.10**). Caution should be used when feeding patients with a BMI less than 18.5 kg/m² (**Table 3.10**).

Table 3.10. Estimation of protein requirements at the extremes of BMI.

BMI	Guide
BMI > 30kg/m²	Use approximately 75% of the value estimated from actual weight
BMI > 50kg/m²	Use approximately 65% of the value estimated from actual weight
BMI < 18.5kg/m²	Start at the upper end of the range (1.5g/kg/actual body weight/day) and monitor regularly, as 1.0 to 1.5g/kg actual body weight/day may result in underfeeding

PENG Requirements Guideline Group Consensus Opinion, 2018.

Protein requirements in parenteral nutrition

It has been recognised since the 1930's that the commonly used factor of 6.25 for conversion of nitrogen values to protein is just an approximation (Jones, 1931). It was based on the assumption that many food based proteins contain around 16% nitrogen. However, the actual nitrogen content

will vary according to the amino acid content (Fujihara *et al*. 2001). Parenteral nutrition amino acid solutions vary in their amino acid content and each would, in theory, have its own specific conversion factor which could be significantly different to 6.25. It is recommended that when estimating nitrogen requirements dietitians use the method for protein detailed in this section and convert to nitrogen using 6.25 but accept that this is just an approximation to give a starting point, after which monitoring and adjustment are crucial.

Table 3.9 Recommendations for estimating protein requirements in adults.

Clinical Condition	Protein Recommend-ations	Guideline Title	Summary of Types of Studies Included (e.g. 2 x Randomised Controlled Trail RCT)	Comments
Burns				
Adults with major burns	1.5-2.0g/kg/day	European Society for Clinical Nutrition and Metabolism (ESPEN) endorsed recommendations: nutritional therapy in major burns (Rousseau *et al*. 2013)	2 RCTs (1 in children) and 1 paediatric guideline	Includes some critically ill patients (major burns at beginning of treatment) also some adult and paediatric papers but only adult recommendations reported. Systematic review. Quality of the evidence assessed using the GRADE* process.
Burn injury	1.5– 2.0g/kg/day	International Society for Burn Injury (ISBI) Practice Guidelines for burn care (ISBI Practice Guidelines Committee, 2016)	1 RCT (reported twice); 2 cohort studies (1 in children); 3 observational studies (1 in children) and 4 review papers	Systematic review. No formal grading process used to assess the quality of the evidence.
Cancer				
Adult cancer patients and cancer survivors independent of severity of disease, stage of disease, or comorbidities	>1g/kg/day, if possible up to 1.5g/kg/day	ESPEN guidelines on nutrition in cancer patients (Arends *et al*. 2017)	1 letter; 6 reviews; 3 guidelines (1 in renal) and 2 observational studies	Systematic review. Quality of the evidence assessed using the GRADE* process.
Patients receiving radiation therapy	Minimum of 1.2g/kg/day	Workshop of expert dietitians (Australia). Evidence based practice guidelines for nutritional management of patients receiving radiation therapy (Isenring *et al*. 2008)	1 RCT	Non-English and case report studies were excluded. Systematic review. Quality of the evidence assessed using NHMRC** grading system.

*GRADE: Grading of Recommendations Assessment, Development and Evaluation ** National Health and Medical Research Council

Table 3.9 Recommendations for estimating protein requirements in adults (continued).

Clinical Condition	Protein Recommendations	Guideline Title	Summary of Types of Studies Included (e.g. 2 x RCT)	Comments
GI disease				
Inflammatory bowel disease (IBD)	1.2 to1.5g/kg/day (active IBD)	ESPEN guidelines on clinical nutrition in IBD (Forbes *et al*. 2017)	1 review and 2 observational studies (1 in children)	Systematic review. Quality of the evidence assessed using the SIGN*** grading system.
	1g/kg/day (remission)		1 systematic review; 1 observational study (in adolescents) and 1 RCT	
Patients with chronic intestinal failure (CIF) due to benign disease	Protein requirements based on individual patient characteristics (e.g. intestinal absorptive capacity/ anatomy / underlying disease)	ESPEN guidelines on chronic intestinal failure in adults (Pironi *et al*. 2016)	3 guidelines and 1 systematic review	Systematic review. Quality of the evidence assessed using the GRADE* process.
Home parenteral nutrition				
Home parenteral nutrition	0.8 - 1.4g/kg/day	Australasian Society of Parenteral and Enteral Nutrition (AuSPEN) Home Parenteral Nutrition Guidelines (Gillanders *et al*. 2008)	1 guideline	Systematic review. Guidelines appraised using AGREE**** instrument.
	0.8 – 1.0g/kg/day (unstressed patients) Up to 2.0g/kg/day in stressed or catabolic patients	ESPEN Guidelines on Parenteral Nutrition: home paremteral nutrition (HPN) in adult patients (Staun *et al*. 2009)	0 papers	Systematic review. Quality of the evidence assessed using SIGN*** grading system
	0.8 - 1.5g/kg/day	Development of quality of care interventions for adult patients on home parenteral nutrition (HPN) with a benign underlying disease using a two-round Delphi approach (Dreesen *et al*. 2013)	5 guidelines	Systematic review of guidelines. No formal grading of the guidelines and Delphi process to achieve consensus.

*** SIGN Scottish Intercollegiate Guidelines Network **** AGREE Appraisal of Guidelines Research and Evaluation

Table 3.9 Recommendations for estimating protein requirements in adult. (continued).

Clinical Condition	Protein Recommendations	Guideline Title	Summary of Types of Studies Included (e.g. 2 x RCT)	Comments
Liver				
Alcoholic steatohepatitis receiving enteral nutrition (EN)	1.2- 1.5g/kg/day	ESPEN Guidelines on Enteral Nutrition: Liver Disease (Plauth *et al.* 2006)	1 observational study, 1 cohort study and 3 RCT's	Systematic review Quality of the evidence assessed using SIGN*** grading system A number of the studies looked at safety of enteral nutrition or safety of enteral protein rather than actual protein intake
Cirrhosis receiving EN	1.2- 1.5g/kg/day		1 observational study, 7 RCT's, 1 literature review. 1 guideline	
Liver transplantation: postoperative	1.2- 1.5g/kg/day		3 RCT's	
Alcoholic steatohepatitis receiving parenteral nutrition (PN)	1.2g/kg/day without malnutrition or moderately malnourished	ESPEN Guidelines on Parenteral Nutrition: Hepatology (Plauth *et al.* 2009)	0 Studies	Systematic review. Quality of the evidence assessed using SIGN*** grading system
	1.5g/kg/day in the severely malnourished			
Cirrhosis receiving PN	1.2g/kg/day compensated cirrhosis without malnutrition		11 RCTs (1 analysed twice)	
	1.5g/kg/day decompensated cirrhosis with severe malnutrition			
	Encephalopathy: standard aa solution in grade ≤II, ↑Branch chain aminoacid (BCAA) and ↓aromatic aa in grade III to IV			
Acute or sub-acute liver failure receiving PN	0.8–1.2g/kg/day		1 controlled study; 1 case review paper (3 cases) and 1 paper.	
Obesity				
Hospitalised obese without severe renal or hepatic dysfunction	High protein hypocaloric feeding	American Society for Parenteral and Enteral Nutrition (ASPEN) Clinical guidelines: nutrition support of hospitalized adult patients with obesity (Choban *et al.* 2013)	2 RCTs; 2 comparative studies and 2 observational studies.	Patients were mainly surgical or intensive care unit (ICU). Systematic review. Quality of the evidence assessed using the GRADE* process.
	Protein: 1.2g/kg actual weight/day or 2-2.5g/kg ideal body weight/day			
	Energy: 50-70% estimated requirements or <14kcal/kg/day			

Table 3.9 Recommendations for estimating protein requirements in adults (continued).

Clinical Condition	Protein Recommendations	Guideline Title	Summary of Types of Studies Included (e.g. 2 x RCT)	Comments
Older adults				
Older adults (>65 years) with complicating medical conditions	1.2 to 1.5g/kg/day	Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group (Bauer *et al*. 2013)	2 observational studies (1 in healthy adults) and 1 systematic review	Not a systematic review; used a "Delphi-like" process to achieve consensus
	Up to 2.0g/kg/day in severe illness, injury, marked malnutrition		2 observational studies (1 in critical care); 1 book chapter and 3 guidelines (all critical care)	Unclear how studies were identified and selected for inclusion and unclear how the quality of the evidence was assessed and graded
Older adults (>65 years) with acute or chronic illness	1.2 to 1.5g/kg/day with even higher intake for individuals with severe illness or injury	ESPEN endorsed recommendations Protein intake and exercise for optimal muscle function with aging: Recommendations from the ESPEN Expert Group (Deutz *et al*. 2014)	A number of papers in healthier older adults and 1 review paper in adults with illness	ESPEN Expert Group Not a systematic review Unclear how studies were identified and selected for inclusion and unclear how the quality of the evidence was assessed and grade.
Polymorbid				
Polymorbid inpatients i.e. at least 2 co-occurring chronic diseases	Minimum of 1.0g/kg/day	ESPEN Guidelines on nutritional support for polymorbid internal medicine patients (Gomes *et al*. 2017)	1 RCT and a subsequent secondary analysis of the same data and 3 guidelines	Systematic review Quality of the evidence assessed using SIGN grading system.
Adult hospitalised patient; unable to sustain volitional intake, expected to remain in hospital >3d and in ICU or general ward.	Protein should be determined independently of energy with ongoing assessment of protein provision	American College of Gastroenterology (ACG). ACG clinical guideline nutrition therapy in the adult hospitalized patient (McClave *et al*. 2016)	2 observational studies (in ICU) and 2 review papers (1 in ICU)	Systematic review Quality of the evidence assessed using the GRADE* process

Table 3.9 Recommendations for estimating protein requirements in adults (continued).

Clinical Condition	Protein Recommendations	Guideline Title	Summary of Types of Studies Included (e.g. 2 x RCT etc)	Comments
Pressure Ulcers				
Adults at risk of pressure ulcers	Mixed nutritional supplementation (energy and protein) may reduce pressure ulcer development	Nutritional interventions for preventing and treating pressure ulcers (Langer and Fink, 2014)	7 RCTs (pooled into meta-analysis)	Cochrane systematic review. Quality of the evidence assessed using the Cochrane Collaboration Toolkit
	1.25-1.5g/kg/day	Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline (National Pressure Ulcer Advisory Panel (NPUAP) & European Pressure Ulcer Advisory Panel (EPUAP), 2009)	2 guidelines and 1 meta-analysis	Systematic review. Quality of the evidence assessed using the GRADE* process.
Adults with pressure ulcers	No clear evidence that mixed nutritional supplements improve pressure ulcer healing	Nutritional interventions for preventing and treating pressure ulcers (Langer and Fink, 2014)	14 RCTs	Cochrane systematic review. Quality of the evidence assessed using the Cochrane Collaboration Toolkit
	1.25-1.5g/kg/day	Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline (NPUAP & EPUAP, 2009)	4 RCTs (1 in critical care)	Systematic review. Quality of the evidence assessed using the GRADE* process.
Surgery				
Enterocutaneous fistula (ECF) defined as an abnormal connection between the gastrointestinal tract and the skin	1.5 to 2.0g/kg/day Up to 2.5g/kg/day in high output entero-atmospheric fistula	American Society for Parenteral and Enteral Nutrition (ASPEN)-FELANPE Clinical Guidelines (Kumpf *et al*. 2017)	0 Studies	Systematic review. Quality of the evidence assessed using the GRADE* process.
Surgical patients at risk (substantial weight loss, low BMI (<18.5-22kg/m^2), inflammatory response)	1.5 g/kg ideal body weight/day (or 20% of total energy requirements) Protein: fat: glucose caloric ratio of 20:30:50%	ESPEN Guidelines on Parenteral Nutrition surgery (Braga *et al*. 2009)	1 cohort study; 2 RCT's (1 in ICU); 1 observational study (paediatrics); 1 conference abstract and 1 observational study (ICU)	Systematic review. Quality of the evidence assessed using the SIGN*** grading system. Unclear why ideal or adjusted body weight was recommended

Estimation of carbohydrate requirements for adults

(Wolfe, Allsop and Burke, 1979; Sauerwein and Romijn, 1994)

The primary goal of providing energy is the provision of substrates for oxidation.

- Glucose requirements for the chronically sick can be set at 4-5g/kg/day.
- For individuals who are critically ill or who have acute respiratory problems it is important to base estimations of requirements on the rate of glucose oxidation in order to prevent excess CO_2 production.
- **Glucose oxidation rate = 4 to 7mg/kg body weight/min/ day.**

For example: If a patient weighs 70kg, estimated glucose oxidation rate is:

{[(4 to 7mg x 70kg) x 60minutes] x 24hours} /1000 =

= 403-706g/day i.e. ≈400-700g glucose /day ≈ 1600-2800 calories from glucose

60 minutes refer to how many minutes are in 1 hour
24 hours refer to how many hours are in 1 day
The result is then divided by 1000 in order to convert mg to g

- Excess glucose is not oxidized but stored as glycogen.
- Glycogen storage capacity is about 15g/kg. Therefore, massive intakes of carbohydrates > 500g/day will, after a few days, result in lipogenesis.

Estimation of lipid requirements for adults

- Usually approximately 1.0 to 1.5g/kg actual body weight/ day.
- Prevention of deficiency of essential fatty acids (EFA):
  - o Diets should provide a minimum of 1 to 2% of total dietary energy as EFA or a minimum of 2 to 5 g/day of linoleic acid (COMA, 1991).
  - o linoleic acid should provide at least 1% of total energy and alpha linolenic acid at least 0.2% of total energy (COMA, 1991).

Estimation of fluid, electrolytes and micronutrient requirements for adults

The management of fluid and electrolytes can be complex in metabolically unstable patients and the NICE guideline on intravenous (IV) fluid management (NICE, 2013) is an essential resource to help clinicians avoid life threatening complications such as dehydration, fluid overload, electrolyte and acid base disturbances.

Improved surgical outcomes are demonstrated when attention to fluid balance is maintained and patients are not overloaded (Lobo *et al*. 2002) and enhanced recovery after surgery (ERAS) protocols are now established in many countries and supported by international guidelines (Lassen *et al*. 2012; Nygren *et al.* 2012; Gustafsson *et al*. 2013).

Decisions regarding the prescription of artificial nutrition support require a careful and thorough assessment of the individual patient. The NICE guideline (2013) contains algorithms covering assessment, fluid resuscitation, fluid maintenance and replacement and redistribution. Adult requirements for fluid and electrolytes can be seen in **Table 3.11**.

A review in 2012 investigating the derivation of equations for estimating fluid requirements reported limited evidence in a small number of subjects therefore highlighting the importance of ongoing monitoring (Vivanti, 2012).

When estimating fluid and electrolyte requirements an assessment of other sources needs to be taken into consideration including IV fluids (**Table 3.12**), IV medications, blood products, oral and enteral sources. When estimating sodium requirements, an assessment of the **sodium content of medications** should be considered (see **Section 13**). For example: paracetamol contains about 17mmol per 500mg. If prescribed 1g four times a day, this equates to 136mmol of sodium per day (White and Bradnam, 2015).

Table 3.11. Adult requirements for fluid and electrolytes.

	Daily baseline requirements		Other considerations
	Oral/enteral (Tyler 1989; Department of Health 1991)	**Parenteral** (Tyler, 1989; NICE, 2013)	
Fluid			
Maintenance requirements Replacement of losses: • Pyrexia • Loss of body fluids (urine, gastrointestinal losses, drains, etc.)	**18-60 years 35ml/kg/day** **> 60 years 30ml/kg/day** • In the unlikely event that pyrexia is untreated, clinicians may need to consider adding 2 – 2.5ml/kg for each °C rise in temperature above 37°C • must be assessed on an individual basis	**25-30ml/kg/day** (NICE, 2013)	Extra bicarbonate may be required in cases of biliary, pancreatic, small bowel and diarrhoea fluid losses. For patients who are obese, adjust the IV fluid prescription to their ideal body weight. Use lower range volumes per kg (patients rarely need more than a total of 3 litres of fluid per day) and seek expert help if their BMI is more than 40kg/m^2. Consider prescribing less fluid (20–25ml/kg/day) for patients who are older or frail, have renal impairment or cardiac failure, are malnourished and at risk of refeeding syndrome (NICE, 2013).
Electrolytes			
Sodium	25 – 70mmol* (1.0mmol/kg)	1mmol/kg (NICE, 2013)	Pyrexia – In the unlikely event that pyrexia is untreated, clinicians may need to consider adding 1.5mmol Na^+ to each 10ml additional fluid required as calculated above. Additional sodium may be required when hyponatraemic but check fluid balance first and consider other possible causes (ascites, over-hydration).
Potassium	50 – 90mmol* (1.0mmol/kg)	1mmol/kg (NICE, 2013)	Additional K^+ will be required if hypokalaemic (check magnesium in hypokalaemia refractory to treatment).
Calcium	10 – 17.5mmol*	0.1 – 0.15mmol/kg	Hypocalcaemia may be due to a decrease in the transport protein albumin because ~50% of calcium is bound to albumin. Most laboratories report both values (calcium and corrected calcium). To calculate corrected calcium Calcium (mmol/l) + (40-serum albumin (g/l)/40).
Magnesium	Men 7.8-12.3mmol* Women 6.2-10.9mmol*	0.1 – 0.2mmol/kg	Hypomagnesaemia may be due to a decrease in the transport protein albumin because magnesium is bound to albumin.
Phosphate	RNI for phosphate should be equal to the RNI for Ca^{++} in mmol*	0.5 – 0.7mmol/kg *or* 10mmol/1000kcal	Do not exceed 50mmol phosphate/day during enteral and parenteral nutrition.
Chloride	RNI for chloride should be equal to the RNI for Na^+ in mmol*	1mmol/kg	The concentration of chloride given is similar to that of sodium.

*ranges given are LRNI – RNI (Department of Health, 1991). The LRNI will meet the requirements of only a few people who have low needs. The RNI will meet the requirements of 97% of the population during health and thus should be the target intake. More may be required in patients with poor status, increased losses from diarrhoea, stoma/fistulae, nasogastric aspirates/vomiting or venting gastrostomies or altered requirements due to disease process.

Medications administered IV can contribute a significant amount of fluid and sodium if delivered in 0.9% sodium chloride which will need to be taken into account during estimations of requirements (**Table 3.13**). Please check with your pharmacist.

Table 3.13. Sodium content of medications if diluted with IV 0.9% sodium chloride.

Volume of 0.9% sodium chloride	Sodium (mmol)
100ml	15.4
250ml	38.5
500ml	77

An assessment of the composition of gastrointestinal losses (Lee, 1974) will also be required and the composition of body secretions is shown in **Table 3.14** and **Figure 3.4**. More detail can be found in the NICE guidelines (NICE, 2013). A systematic review investigating the sodium content of body fluids found a wide variation in different clinical populations therefore ongoing monitoring is essential (Kaptein *et al*. 2016). If in doubt seek senior advice. There is no evidence for the fluid and electrolyte requirements of patients at extremes of BMI and therefore ongoing monitoring is imperative to prevent complications.

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PENG Requirements Guidelines Group Consensus Opinion, 2018

Where data from clinical studies were absent or conflicting, the Guideline Development Group held a series of consensus development meetings (face-to-face or online) during which the relevant issues were discussed and voted on prior to circulation for peer review.

Decisions made in this way are indicated by the following term: PENG Requirements Guideline Group Consensus Opinion, 2018.

For references please refer to the PENG Pocket Guide print edition available here.