1. Introduction and Who Guideline applies to

Calculation of energy and protein requirements on an adult critical care patient is becoming more complex with different equations available and conflicting evidence. These are often different depending on Body Mass Index (BMI), ventilation mode and activity levels. Some variables can change frequently and so requirements should be checked at least twice weekly, more frequently if required. Predictive equations should be used to estimate energy requirements in the absence of indirect calorimetry which is currently unavailable in the Trust.

When devising a feeding plan, it is important to ensure that energy and protein requirements are considered together whilst also appreciating other elements such as adequate carbohydrate and micronutrient provision.

These guidelines are for use by Dietitians on all patients on the Adult Critical Care units in University Hospitals of Leicester NHS Trust. It applies to patients regardless of the route of feeding, i.e. oral, enteral or parenteral feeding.

2. Guideline Standards and Procedures

Calculation of Energy Requirements

In order of preference, the following should be used to calculate energy requirement (ESPEN, 2019):

1. Indirect calorimetry – 'Gold' standard but not currently available in UHL.
2. Consider checking VCO2 – Carbon dioxide production derived from the ventilator and using REE=VCO2 x 8.19.
3. Where there is an accurate minute volume, Penn State (PSU) predictive equations – most accurate predictive equation compared to indirect calorimetry in nearly all groups of mechanically ventilated, critically-ill patients (Frankenfield, 2009)
4. Mifflin St Joer (MSJ) for patients with BMI >30 with no accurate minute volume or on ECMO
5. Weight based calculations for those with no accurate minute volume or are on ECMO

As all requirements are estimated, it is important to check against other equations and apply clinical judgement as indicated on an individual patient basis.

It is also important to ensure that weight and height measurements are as accurate as possible so it is important to use a measured weight and height. However, if not available, a recalled weight and height can be used from either the patient or a relative. A search of medical notes, electronic patient records or the GP record may also yield a recent measured weight or height.

A height may be obtained from an ulna length measurement if there is no measured height or in the case of significant discrepancy, which, if needed, can then be used with an estimated weight to estimate BMI.

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Energy requirements for patients with a minute volume and NOT on ECMO

Obtain age, weight, height, calculate BMI

Calculate requirements using the following equations (Mifflin St Joer equations):

MEN: (10 x weight (kg) +(6.25 x height cm) – (5 x age) + 5

WOMEN: (10 x weight kg) + (6.25 x height cm) – (5 x age) – 161

Check BMI and Age

If BMI ≤ 30.0 use Penn state equations 2003*:)

If BMI > 30 and patient is less than 60 years old use Penn State equations (2003*),

*Penn State Equation (PSU) = Mifflin (0.96) + (max temperature in last 24 hour x 167) + (current minute ventilation x 31) – 6212

If BMI > 30 and pt is 60 years old or more, use adjusted PENN State equation (2011*)

*Adjusted Penn State = Mifflin (0.71) + (max temperature in the last 24 hours x 85) + (current minute ventilation x 64) – 3085

Energy Requirements for patients with no minute volume or on ECMO

Obtain age, weight, height, calculate BMI

Patients with BMI ≤30.0:

1. 20 - 25 kcals per kg catabolic

OR

2. 25-30 kcals per kg for rehab/ anabolic phase

If BMI is >30- 50.0 kg/m²

1. Use MSJ as above

OR

2. If rehab consider MSJ x 1.2

OR

3. 14 kcals per kg actual body weight

If BMI > 50 kg/m2

1. Use MSJ as above

OR

2. 22-25 kcals per kg ideal body weight

(NB: Where BMI is >30- 50.0 kg/m² and BMI > 50 kg/m^2, hypocaloric feeding with adequate protein aims to maintain lean body mass whist simultaneously losing fat mass. Underfeeding calories aims at avoiding the metabolic complications associated with overfeeding in critically-ill patients such as hyperglycaemia, increased infections and increased ventilator days).

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Calculation of Protein Requirements

It is widely acknowledged that the provision of protein is closely linked to positive outcomes in the critical care setting. Protein is the most important macronutrient for minimising loss of lean body mass, wound healing and supporting immune function. Higher targets in critical care are recommended compared to general hospitalised patients due to the effect of catabolism driving protein breakdown.

Unfortunately, determination of protein requirements remains difficult and therefore, weight-based equations and application of clinical judgement for disease-specific requirements is recommended in both European and International guidelines (McClave *et al*, 2016; Singer *et al*, 2019) and caution required in patients with AKI or high organ failure scores (Heyland et al 2023).

Patients with a BMI < 30kg/m^2:

1. General ICU patients and ECMO – 1.3-1.5g/kg protein (a higher threshold of 2g/kg protein may be appropriate in the presence of significant wounds or extrinsic losses).
2. Trauma – 1.3-1.5g/kg protein
3. Continuous Renal Replacement Therapy (CRRT) - 1.5-1.7g/kg protein
4. If AKI/CKD present and no plan for Continuous Renal Replacement Therapy – 1g/kg protein
5. If CKD and on intermittent/overnight e.g. SLED/ HF continue to aim for 1g protein/kg

Patients with a BMI ≥30 kg/m²:

Based on current European guidelines and clinical practice, calculate a range using 1.3g/kg protein based on:

(a) Adjusted body weight with ideal body weight calculated to a BMI 25kg/m^2: (actual body weight – ideal body weight) x 0.33 + ideal body weight

(b) Actual body weight

However, in this should be adjusted in the following clinical scenarios:

1. If AKI/CKD present and no plan for Continuous Renal Replacement Therapy – 1g/kg protein using actual body weight
2. If CKD and on intermittent/overnight dialysis (e.g. SLED/HF) - 1g/kg protein using actual body weight
3. For ECMO patients, consider estimating as above but use clinical judgement on an individual patient basis as higher protein requirements may be indicated.

Specific considerations for pregnancy (NB data limited)

Use equations as above using pre-pregnancy or booking weight (unless visible/obvious weight loss). Interpret using clinical judgement.
Consider adding additional calories 200-300 kcals in 3rd trimester for baby growth.

OR

If no pre-pregnancy or booking weight, use equations above and actual body weight but **do not** add additional calories for weight gain
Consider checking with midwives about USS to check for baby growth and liaising directly with them.

Check vitamin A content of the enteral feed does not exceed 2000 mcg and check no other sources of vitamin A. No need to routinely check vitamin A unless concern about low levels.

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NB: Paper copies of this document may not be most recent version. The definitive version is held in the Policies and Guidelines Library

3. Education and Training

Education and discussion will be through Critical Care Dietitian meetings with case studies for clinical supervision.

4. Monitoring Compliance

What will be measured to monitor compliance	How will compliance be monitored	Monitoring Lead	Frequency	Reporting arrangements
Patients requirements are calculated using these recommendations and documented with rationale in patients' medical notes	Review of electronic handover	Moira Dawson Aileen Case	Annually	

5. Equality Analysis Assessment

The Trust recognises the diversity of the staff and local community it serves. Our aim therefore is to provide a safe environment free from discrimination, harassment and victimisation and treat all individuals fairly with dignity and respect and, as far as is reasonably possible, according to their needs.

As part of its development, an Equality Analysis on this policy have been undertaken and its impact on equality have been reviewed and no detriment was identified.

EDI Statement

We are fully committed to being an inclusive employer and oppose all forms of unlawful or unfair discrimination, bullying, harassment and victimisation.
It is our legal and moral duty to provide equity in employment and service delivery to all and to prevent and act upon any forms of discrimination to all people of protected characteristic: Age, Disability (physical, mental and long-term health conditions), Sex, Gender reassignment, Marriage and Civil Partnership, Sexual orientation, Pregnancy and Maternity, Race (including nationality, ethnicity and colour), Religion or Belief, and beyond.

We are also committed to the principles in respect of social deprivation and health inequalities.

Our aim is to create an environment where all staff are able to contribute, develop and progress based on their ability, competence and performance. We recognise that some staff may require specific initiatives and/or assistance to progress and develop within the organisation.

We are also committed to delivering services that ensure our patients are cared for, comfortable and as far as possible meet their individual needs.

6. Supporting References

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7. Key Words

Nutritional Requirements, Critical Care

CONTACT AND REVIEW DETAILS	
Guideline Lead (Name and Title) **Moira Dawson – ACP Dietitian (Critical Care)**	**Executive Lead:**
Details of Changes made during review: **September 2024** • Updated references • Added statement about consistency checking with other equations • Updated to include intermittent dialysis use as the frequency of this has increased • Changed layout of pregnancy section to improve flow of document • Changed format to new template	