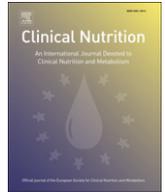


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Letter to the Editor

Protein recommendations in the ICU: g protein/kg body weight – which body weight for underweight and obese patients?

In the ESPEN guideline for parenteral nutrition in the ICU,¹ it is recommended to provide 1.3–1.5 g protein or amino acids per kg ideal body weight (IBW) per day. The purpose is to avoid over-feeding of protein in patients who are either severely obese or oedematous. However, a guide to estimating IBW was not given. In the ICU, the Devine equation based on height² is often used, e.g. for deciding tidal volume.³

Further, a recent observational study showed that reaching clearly defined targets for energy and protein was associated with a decreased hazard ratio for death.^{4,5} The targets were provision of energy in accordance with measurement by indirect calorimetry and provision of protein in a dose of 1.2 g/kg actual body weight (ABW),⁶ except in patients with a BMI ≥ 30 for whom target was set to be $1.2 \text{ g} \times \text{height (m)}^2 \times 27.5$. The recommendation for non-obese patients is based on the measured loss of whole body nitrogen in relation to provision of protein, expressed per kg fat-free mass (FFM), as measured in the original publication.⁷ The recommendation for obese patients is a pragmatic and arbitrary allowance both for the higher FFM in obese individuals and the relative decrease in FFM with increasing BMI.^{8,9} The value 27.5 is BMI halfway between the upper limit of the normal range and obesity (BMI ≥ 30).

However, with the assumption that FFM is the true determinant of protein requirement, the use of IBW or ABW will lead to under-feeding of protein in some patients and over-feeding of protein in other patients (see discussion of Table 1 below). In particular, the use of ABW will lead to under-feeding of protein in underweight patients, since FFM is relatively increased with decreasing body weight.⁸

We suggest that the target in Refs. 4, 5 is extended to include underweight patients by the formula:

Protein target (BMI_{20_30} formula):

- BMI 20–30: 1.2 g/kg actual body weight (ABW);
- BMI <20: $1.2 \text{ g} \times \text{height (m)}^2 \times 20$;
- BMI >30: $1.2 \text{ g} \times \text{height (m)}^2 \times 27.5$.

To illustrate this point, we wish to compare this target to those obtained by other methods, including an estimate of FFM. Ideally, FFM should be measured in each ICU patient, but a sufficiently validated method is not available for routine use in clinical practice. Instead, FFM can be estimated from equation (5) in Ref. 10. This equation was based on measurement of FFM in almost 700 healthy individuals employing the four compartments technique (DEXA scanning, deuterium labelled water, densitometry). The participants exhibited a range of BMI from 16 to 36. The equation

calculates percent body fat from $1/\text{BMI}$. FFM can be calculated by rearranging the equation, including the interactions of the original equation:

$$\text{FFM} = \text{ABW} \times 0.01 \times \left(100 - \left[64.5 - 848 \times \text{ht}^2 / \text{ABW} + 0.079 \times \text{age} - 16.4 \times \text{sex} + 0.05 \times \text{sex} \times \text{age} + 39.0 \times \text{sex} \times \text{ht}^2 / \text{ABW} \right] \right);$$

ht = height in meter; sex = 1(male), sex = 0(female).

We prefer this equation to the earlier commonly used Hume equation,¹¹ derived from measurement of total body water by dilution of antipyrine in about 60 healthy, obese or diseased individuals.

Table 1 was constructed by calculating ABW from values of height taken from the average \pm 1SD of male and female participants in Ref. 10 and from selected values of BMI to represent the moderately obese and underweight ICU patient. Different heights were tested to examine the sensitivity of the calculations. Age was set to 50 years in all calculations. The target 1.5 g/kg FFM is taken as the “true” target. The use of ABW alone leads to under-feeding of protein in underweight males and to over-feeding in overweight patients. The use of IBW leads to over-feeding in underweight patients and under-feeding in overweight patients. Our suggestion matches the 1.5 g/kg FFM target quite well in males but over-estimates the target by about 18% in females. The BMI_{20_30} targets in Table 1 should therefore be reduced by 15% in female patients.

It is clear from Table 1 that the method of expressing body weight considerably influences the targets for provision of protein. In our opinion, the protein target in the ICU should be defined by the use of estimated¹⁰ or measured FFM,⁷ but the BMI_{20_30} formula is an easier bedside method. The FFM values calculated in Table 1 may not be valid for ICU patients, but the principle of a large variation of FFM as a proportion of ABW, ranging from 60% to 90% in the examples of Table 1, most likely also applies to the ICU patient.

By this correspondence, we do not wish to claim that the value 1.5 g protein/kg FFM, corresponding to 1.2 g/kg ABW in a normal-weight male patient, is clinically superior to the 1.3–1.5 g protein or amino acids per kg IBW recommended by ESPEN.¹ However, we recommend using our approach instead of IBW, e.g. as determined by the commonly used Devine equation,² in order to allow for the variation in FFM as proportion of body weight in underweight and obese patients.

In terms of clinical outcome, the targets employed in Refs. 4, 5 were associated with improved survival, provided that both

Table 1
Protein targets calculated from various body weights.

Height	BMI	ABW, kg	FFM, kg	IBW, kg	Protein target			
					1.5 g/kg FFM	1.2 g/kg ABW	1.2 g/kg IBW	1.2 g/kg BMI_20_30
Male								
Average								
176	18	56	50	71	76	67	86	74
176	25	77	60	71	90	93	86	93
176	32	99	70	71	105	119	86	102
+1SD								
184	18	61	55	79	83	73	95	81
184	25	85	66	79	99	102	95	102
184	32	108	77	79	115	130	95	112
-1SD								
168	18	51	46	64	69	61	77	68
168	25	71	55	64	82	85	77	85
168	32	90	64	64	96	108	77	93
Female								
Average								
163	18	48	38	55	56	57	66	64
163	25	66	43	55	65	80	66	80
163	32	85	49	55	74	102	66	88
+1SD								
170	18	52	41	62	61	62	74	69
170	25	72	47	62	71	87	74	87
170	32	92	54	62	81	111	74	95
-1SD								
156	18	44	34	49	52	53	59	58
156	25	61	40	49	60	73	59	73
156	32	78	45	49	68	93	59	80

ABW = Actual body weight; FFM = Fat-free mass¹⁰; IBW = Ideal body weight³; BMI_20_30: See text.

individually defined targets for energy and protein were reached. However, without the adjustment for underweight, this target (1.2 g protein × ABW) probably leads to under-feeding of protein in underweight patients. Only future intervention trials will provide an accurate recommendation for protein, based on clinical outcome and allowing for the stress–metabolic effect of hormones and cytokines on the normal metabolism of FFM. The issue of the influence of overhydration/edema has not been discussed here. We recommend to use pre-admission body weight, as in Ref. 7.

Conflict of interest

None declared.

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Peter J.M. Weijs*

Dept of Nutrition and Dietetics, Internal Medicine,
VU University Medical Center, De Boelelaan 1117,
1081 HV Amsterdam, The Netherlands

Dept of Intensive Care Medicine, VU University Medical Center,
Amsterdam, The Netherlands

Dept of Nutrition and Dietetics, School of Sports and Nutrition,
Amsterdam University of Applied Sciences,
Amsterdam, The Netherlands

Hans P. Sauerwein

Dept of Endocrinology, Maastricht University Medical Center,
Maastricht, The Netherlands

Jens Kondrup

Clinical Nutrition Unit, Rigshospitalet University Hospital,
Copenhagen, Denmark

* Corresponding author. Dept of Nutrition and Dietetics,
Internal Medicine, VU University Medical Center,
De Boelelaan 1117, 1081 HV Amsterdam, The Netherlands.
Tel.: +31 204443211.

E-mail addresses: p.weijs@vumc.nl, p.j.m.weijs@hva.nl (P.J.M. Weijs)

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