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Corresponding Author:	Elisabeth De Waele, MD PhD Universitair Ziekenhuis Brussel Jette, BELGIUM
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Corresponding Author's Secondary Institution:	
First Author:	Elisabeth De Waele, MD PhD
First Author Secondary Information:	
Order of Authors:	Elisabeth De Waele, MD PhD
	Zenzi Rosseel, Pharmacist
	Joeri Pen, MD PhD
Order of Authors Secondary Information:	

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Current Opinion in Critical Care

Post-ICU nutrition: the neglected side of metabolic support

Elisabeth De Waele[1,2,3], Zenzi Rosseel[1,4] and Joeri J. Pen[3,5]

1. Department of Clinical Nutrition, Universitair Ziekenhuis Brussel (UZB), 1090 Brussels, Belgium. Elisabeth.dewaele@uzbrussel.be (EDW); Zenzi.rosseel@uzbrussel.be (ZR)
2. Department of Intensive Care, Universitair Ziekenhuis Brussel (UZB), 1090 Brussels, Belgium. Elisabeth.dewaele@uzbrussel.be (EDW);
3. Faculty of Medicine and Pharmacy, Vrije Universiteit Brussel (VUB), 1090 Brussels, Belgium. Elisabeth.dewaele@uzbrussel.be (EDW); joeri.pen@uzbrussel.be (JP)
4. Department of Pharmacy, Universitair Ziekenhuis Brussel (UZB), 1090 Brussels, Belgium. Zenzi.rosseel@uzbrussel.be (ZR)
5. Department of Internal Medicine, Diabetes Clinic, Universitair Ziekenhuis Brussel (UZB), 1090 Brussels, Belgium. joeri.pen@uzbrussel.be (JP)

Correspondence: elisabeth.dewaele@uzbrussel.be; Tel.: +32-2-476-3354

Abstract

Purpose of this review

This review will focus on the neglected side of metabolic support in ICU survivors: nutritional therapy after critical illness. Knowledge of the evolution of the metabolism of patients that survived critical illness will be bundled, and current practices will be investigated. We will discuss some studies conducted to determine resting energy expenditure in ICU survivors and which identified barriers that cause interruptions in the feeding process based on published data between January 2022 and April 2023.

Recent findings

Resting energy expenditure can be measured using indirect calorimetry, as predictive equations have proven to fail in their attempt to have good correlations with measured values. No guidelines or recommendations are available on post-ICU follow-up, including screening, assessment, dosing, timing and monitoring of (artificial) nutrition. A limited number of publications shared treatment adequacy between 64-82% for energy (calories) and 72-83% for protein intake in a post-ICU setting. Loss of appetite, depression and oropharyngeal dysphagia are the most prominent physiological barriers responsible for decreased feeding adequacy.

Summary

Patients may be in a catabolic state during and after ICU discharge, with several factors impacting metabolism. Therefore, large prospective trials are needed to determine the physiological state of ICU survivors, determine nutritional requirements and develop nutritional care protocols. Many barriers causing decreased feeding adequacy have already been identified, but solutions are scarce. This review depicts a variable metabolic rate among ICU survivors

and a significant variation in feeding adequacy in-between world regions, institutions, and patient sub-phenotypes.

Keywords

ICU survivor; feeding adequacy; malnutrition; metabolic support; barriers

Introduction

Currently, several guidelines and recommendations on nutritional therapy exist for critically ill patients based on variable levels of evidence. In addition to screening, assessment, timing, and feeding route, dosing (artificial) nutrition is discussed. Knowledge of the patient's energy expenditure is of cardinal importance in this domain. When considering the metabolism of ICU patients and their confounders, the significant difference between predicted and measured resting energy expenditure (REE) in mechanically ventilated patients is confirmed in recent work [1]. Although guidance is openly available, implementation remains a challenge, as nutritional adequacy (both in energy and protein) varies enormously, as proved by the 'NutritionDay' initiative [2], as well as several other publications, including inadequate feeding in the cardiac surgery sub phenotype ICU population [3]. From a patient's perspective, continuity of care seems obvious. Nevertheless, due to the current hospital structure, care is often fractioned, and hand-over of patients occurs, such as in the transition from ICU to the ward. The impact on nutritional therapy is real.

What is the metabolic state and the evolution of the metabolism of an ICU survivor?

A study on 55 adult ICU survivors revealed a measured EE of 22-23 kcal/kg/day, with an interquartile range of 15-24 kcal/kg/day four days after ICU discharge, and no gender difference could be found [4]. This EE was significantly lower than the traditionally suggested 30 kcal/kg/day and could not be estimated by the Penn-State or Harris-Benedict equations. Information shared in preprint (lacking peer review) shows a higher mean REE on 44 occasions during the post-ICU ward stay than in ICU: 2032 kcal/day with an average of 29 kcal/kg/day on day 4 in ICU. A mean difference of 2.6 kcal/kg/day was observed [5]. Which of the post-critical illness state: the underlying disease which caused the life-threatening condition or the physiological impact of the survived critical illness, has a more substantial impact on metabolism is unknown.

This raises the question of how energy targets for ICU survivors should be determined. Another question mark is whether an equilibrium with the metabolic rate or an energy intake higher than the REE should be targeted. No data is currently available to answer this question.

How are ICU survivors fed?

This is a relevant question from the perspective of quality control and a patient's experience. Of course, adequacy can only be determined when a target is chosen or calculated. As no beneficial or ideal caloric and protein targets are known, all adequacy studies should be interpreted with caution; it remains to be determined at an individual patient's level, which in practice means most feeding regimens, and studies on the topic, are a shot in the dark.

The PROSPECT-1 study revealed that most patients did not meet energy and protein targets in the post-ICU hospitalization period, but a result of 82% for energy and 83% for protein adequacy is high in contrast to other publications; an Australian dataset showed numbers of 79 and 73%, and the Wittholz data were 64 and 72% for energy and protein, respectively, all of this being discussed in the review of *Slingerland-Boot et al*. [6].

A Belgian observational study conducted at an ICU follow-up clinic revealed an energy adequacy of 73, 79 and 83% at 1,3 and 12 months post-ICU compared to targets for healthy individuals [7]. Handgrip strength was similar in patients with either inadequate energy or protein intake. Net energy and protein intake did not increase over time. In the PROSPECT-1 study, no outcome difference was observed. So, with variable targets set in different investigations, a variating in energy feeding adequacy is observed, but overfeeding is not the dominant observation in these trials. Iatrogenic underfeeding of ICU survivors appears to be the norm.

Barriers causing a decrease in feeding adequacy

Two recent studies investigated the barriers that are responsible for a decrease in feeding adequacy. A Japanese trial with 501 65+ aged ICU survivors studied the loss of appetite using the simplified nutritional appetite questionnaire (SNAQ) 12 months post-ICU. They defined poor appetite as a score under 14. One out of four patients did experience poor appetite. In the latter group, more patients had abdominal surgery, digestive diseases and malignancy, albeit none to a significant level. Length of stay in the hospital was comparable in both groups, also lacking significance. Another factor correlated to loss of appetite is the presence of depression. Patients are less motivated to eat, especially in assisted facilities and community-dwelling older people [8].

Kitamaya et al. focused on the loss of appetite in people aged 65 or older, whereas other physiological, functional and organizational barriers were investigated and discussed in the paper from *Moisey et al.* Loss of appetite is not only caused by the presence of depression and anxiety but also by other cofactors like nausea, vomiting and taste changes. About 11-83% of patients with a tracheostomy will suffer from oropharyngeal dysphagia (OPD) after ICU discharge. In addition to physiological and functional barriers, organizational barriers also cause decreased nutritional intake. Meals delivered at inappropriate times, missed meals and snacks, and interrupted meals due to transfers to the operating room or other medical procedures, are organizational barriers leading to inappropriate nutritional intake. The feeding strategy active in a post-ICU ward patient seems to define the accuracy: the route makes the difference in this population. Due to feeding tube removal during transfer to the ward, patients relying on an oral diet alone reach between 55-75% and 27-74% of prescribed calories and proteins, respectively. On the other hand, when the feeding tube stays in place, the energy and protein adequacy rise to 62-104% and 59-100%, respectively. Not only the hospital structure is

responsible, but also the gap in nutritional knowledge, poor communication, and lower priority of nutritional care are contributing factors [9].

Future

Interventional studies are needed to determine which nutritional strategy can benefit ICU survivors, as currently, there is no strategy tested in a solid research context revealing positive outcomes for ICU survivors. Questions on dosing, route of administration, and monitoring, need to be raised and answered, just as has already been done for decades in the ICU. As stated by *Moisey et al.*, the role of nutrition in the recovery of survivors of critical illness is both under-recognized and under-appreciated. Notwithstanding, with increased knowledge, better-designed studies, and a positive belief and attitude for a change to the best, nutritional therapy quality will undoubtedly increase in the upcoming years, providing many benefits to patients. Let the sun break through the clouds, and we look forward to a bright era.

Conclusion

Overall, it can be stated that the nutritional intake of ICU survivors does not cover the theoretical requirements, whatever goal was set. Currently, an individualized approach to measuring energy expenditure to tailor energy prescription and possibly other means, such as lean body mass measurements for calculating protein needs, is lacking, so knowledge on the topic is scarce. The administration route plays an important role; oral nutrition is typically revealed to be highly inadequate, which is very relevant but often overlooked clinical information. Oral nutritional supplements, enteral nutrition, and parenteral nutrition are critical factors in increasing feeding adequacy [6]. Different barriers to adequate nutrition post-ICU have already been well identified [9], both physiological and functional. Once again, this knowledge is of cardinal importance for clinical practice and can be ground to build upon when increasing the quality of nutritional therapy for ICU survivors.

Key points

- No guidelines or recommendations are available for post-ICU follow-up and nutritional therapy.
- ICU survivors benefit the most from oral, enteral and parenteral nutrition combinations.
- Two recent studies addressed the importance of recognizing barriers causing feeding interruption, but no recent prospective interventional trials have been conducted to solve those barriers.
- There is an urge for large prospective trials investigating ICU survivors' metabolic needs and developing an evidence-based nutritional care protocol.

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Conflicts of interests:

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No conflict of interest is present in this paper.

ZR and JJ report no conflict of interest.

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This is the first article investigating the REE in a post-ICU population. Knowledge about the REE is of cardinal importance for developing guidelines and setting targets on energy and protein intake.

5. Moonen HPFX, Hermans AJH, Snaterse I, Stikkelman E, van Zanten FJL, van Exter SH, van de Poll MCG, van Zanten ARH: **Resting Energy Expenditure Measured by Indirect Calorimetry in Mechanically Ventilated Patients During ICU Stay and Post-ICU Hospitalization: A Prospective Observational Study**. [date unknown], doi:10.2139/SSRN.4384504.

**6. Slingerland-Boot R, van der Heijden I, Schouten N, Driessen L, Meijer S, Mensink M,

van Zanten A: **Prospective observational cohort study of reached protein and energy targets in general wards during the post-intensive care period: The PROSPECT-I study**. *Clin Nutr* 2022, **41**.

Trial with 48 patients but with 484 observational days indicating the importance of a feeding strategy combining oral, enteral and parenteral nutrition. Oral nutrition alone was revealed to be inadequate to meet patients' requirements. With the development of nutritional protocols, attention should be drawn to dose, timing, and what steps should be followed along the way of combining administration routes.

*7. Rousseau AF, Lucania S, Fadeur M, Verbrugge AM, Cavalier E, Colson C, Misset B: **Adequacy of Nutritional Intakes during the Year after Critical Illness: An Observational Study in a Post-ICU Follow-Up Clinic**. *Nutrients* 2022, **14**.

Recently conducted trial with a large cohort of patients (206 patients) with a follow-up from 1 to 12 months post ICU. The authors discussed that only 71% of patients had returned to their preadmission weight one year after ICU discharge. Therefore nutritional guidelines need to be developed for post-ICU follow-up but also for nutritional follow-up after hospital discharge.

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Recent review addressing all investigated barriers causing feeding interruption so far.

This article is essential for upcoming trials for recognizing similar barriers and finding suitable and easy-to-implement clinical practice solutions to avoid and minimize those barriers.

Papers of particular interest published within the period of review have been highlighted as:

* of special interest

** of outstanding interest