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WHAT'S NEW IN INTENSIVE CARE

How to feed a patient with acute kidney injury

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Introduction

Acute kidney injury (AKI) is a frequent complication of critical illness. It commonly occurs in the context of sepsis, multi-organ failure, major surgery or trauma, and is considered a pro-inflammatory condition. Our aim is to highlight the lack of high-quality data related to nutrition in AKI.

Malnutrition, defined by the World Health Organisation as "deficiency, excess or imbalance in a person's intake of energy and/or nutrients", is common in AKI. The main causes are critical illness (systemic inflammation, immobility, muscle breakdown) and pre-existing malnourishment. Increased protein breakdown, impairment of lipolysis, insulin resistance and altered hormonal regulation have also been reported [1]. The effects of retained uremic waste products and middle molecules, altered amino acid pattern and fluid accumulation, are likely to play a role in the development of malnutrition in AKI, too [2] (Supplementary Fig. 1).

In patients receiving renal replacement therapy (RRT), nutritional status may also be affected by the removal of amino acids, trace elements, glucose and water-soluble vitamins [3–5]. The extent varies depending on the modality, dose and duration of RRT and the concentrations of nutrients in serum. During continuous renal replacement therapy (CRRT), amino acid losses up to 10–15 g/day have been reported [4]. However, most studies are small, relatively old and not always reflective of current clinical practice. Nevertheless, a recent study showed that 80% of patients on CRRT had below-normal levels of at least one important micronutrient measured i.e. thiamine, pyridoxine, ascorbic acid, folate, zinc or copper [6]. However, it should be acknowledged that the presence of low plasma nutrient concentrations during CRRT does not necessarily mean that elimination across the filter is the only cause. For instance, Story et al. measured serum concentrations of vitamin C, vitamin E, selenium, zinc, chromium and copper in critically ill patients with and without CRRT and in healthy controls [5]. They showed that CRRT patients had significantly lower serum concentrations compared to healthy controls but there was no difference between both critically ill cohorts. This suggests that acute illness has a greater impact than CRRT per se.

Nutritional assessment

All critically ill patients should undergo a general clinical assessment of nutritional status [7]. However, there is no validated screening tool to assess nutritional requirements specifically in AKI patients [8]. Indirect calorimetry is not widely available, and equations estimating resting energy requirement are unreliable and have not been validated in AKI. Until a specific tool has been validated, it is recommended that a general nutritional assessment should include the exploration of weight loss before ICU admission, a physical examination and an assessment of body composition, muscle mass and muscle strength [7].

Nutritional support

During critical illness, amino acids are released from muscle to support gluconeogenesis and the production of inflammatory mediators. Nutrition can only improve protein and energy balance and possibly protein synthesis but cannot suppress critical illness-induced catabolism.

There is consensus that nutritional support should be individualised and tailored to the severity of hypercatabolism and the underlying disease, comorbidities, the need

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Table 1 Nutritional recommendations in critically ill patients and patients with AKI

Nutritional parameter	Patients with AKI		General ICU patients	
	Recommendations	Level of evidence*	Recommendations	Level of evidence*
Calories	20–30 kcal/kg/day [1, 10] 25–30 kcal/kg/day [11]	5 5	Hypocaloric nutrition (not exceeding 70% of EE) should be administered in the early phase of acute illness After day 3, caloric delivery can be increased up to 80–100% of EE [7]	2c
Protein	AKI during critical illness and not on RRT: Gradual increase to 1.3 g/kg/day [7] Up to 1.7 g/kg/day [1, 10] Critically ill patients on intermittent RRT: 1.0–1.5 g/kg/day [10] 1.5 g/kg/day [9] Critically ill patients on CRRT: Up to 1.7 g/kg/day [1, 10]	 5 5 5 5 5	Progressive increase to 1.3 g/kg/day [7]	2b
Vitamins and trace elements	Recommendation to supplement micronutrient losses during extracorporeal treatment [1]	5	Routine supplementation with glutamine or antioxidants not recommended [12] Recommendation to detect micronutrient deficiencies in patient categories at risk [7]	1b 5

AKI acute kidney injury, *CRRT* continuous renal replacement therapy, *EE* energy expenditure, *ICU* intensive care unit

*Grading as per grading system from the Centre for Evidence-Based Medicine, Oxford

1a: Systematic reviews (with homogeneity) of randomized controlled trials

1b: Individual randomized controlled trials (with narrow confidence interval)

1c: All or none randomized controlled trials

2a: Systematic reviews (with homogeneity) of cohort studies

2b: Individual cohort study or low quality randomized controlled trials (e.g. < 80% follow-up)

2c: "Outcomes" research; ecological studies

3a: Systematic review (with homogeneity) of case–control studies

3b: Individual case–control study

4: Case-series (and poor quality cohort and case–control studies)

5: Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"

for RRT, and pre-existing nutritional status [1, 7, 9–11]. Evidence-based data are limited and randomized controlled trials (RCT) specifically in AKI patients have not been performed. However, recent studies in the general ICU population (including AKI patients) showed important results related to type and timing of nutrition that are likely to be applicable to critically ill patients with AKI [7, 12, 13]. These findings were incorporated in latest guidelines, including the recommendations by the European Society for Clinical Nutrition and Metabolism (ESPEN) [7].

Energy expenditure (EE) tends to be higher during critical illness compared with reference values in healthy individuals [14], but both under- and overfeeding are associated with delayed recovery and increased mortality [13, 15, 16]. The ESPEN guideline recommends hypocaloric nutrition in the early phase of illness, progressing slowly to full targeted nutrition after day 3 with the aim to achieve more than 70% of EE but not more than 100% [7]. Full nutritional support provided early may cause overfeeding as it fails to suppress endogenous energy production which cannot be measured. It also cannot reverse muscle catabolism and may induce refeeding [17]. There is no evidence that caloric targets should be different in AKI patients with and without RRT. However, in patients on CRRT, citrate contributes to caloric delivery and should be accounted for.

If possible, oral diet should be the initial route of nutrition [1, 7, 10, 11]. In patients with insufficient oral intake, enteral feeding within 24–48 h is recommended [7]. Limited data suggest that bolus and continuous enteral feeding can achieve similar targets [7]. When enteral nutrition is contraindicated, parenteral nutrition is recommended within 3–7 days.

With regards to protein targets, the evidence is low. Observational data in the general ICU population suggest that high protein intake is associated with lower mortality; however, a slow progression to target on days 3–5 may be beneficial [15, 16, 18]. Official guidelines vary in their recommendations (Table 1). Whilst some guidelines

recommend a higher protein intake [11] based on older reports, certain well-conducted RCTs showed harm with the provision of early supplemental parenteral nutrition during the first week or supplemental high dose glutamine in patients with multiple organ failure, especially AKI (increased ureagenesis with a potentially increased requirement for RRT, suppression of autophagy, failure to suppress catabolism, increased mortality) [12, 13]. Trials comparing low and high amounts of calories and/or protein are ongoing (ClinicalTrials.gov NCT03292237 and NCT03573739). The most recent ESPEN guidelines recommend to deliver 1.3 g/kg protein equivalents per day gradually [7]. For patients receiving CRRT, experts suggest to administer water-soluble vitamins and trace elements routinely but controversy exists about the type, dose and duration [1] (Table 1).

Unmet needs and future research

Nutrition in AKI is an under-researched area. There are no RCTs on nutrition in patients with AKI. The exact role of routine micronutrient supplementation in patients receiving CRRT remains unknown. More well-designed RCTs are urgently required, in particular to investigate whether different protein targets in combination with hypocaloric nutrition and the supplementation of micronutrients improves outcomes in AKI.

Electronic supplementary material

The online version of this article (https://doi.org/10.1007/s00134-019-05615-z) contains supplementary material, which is available to authorized users.

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