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ORIGINAL ARTICLE

Nutrition support for acute kidney injury 2020-consensus of the Taiwan AKI task force

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Abstract

Background: We used evidence-based medicine to suggest guidelines of nutritional support for Taiwanese patients with acute kidney injury (AKI).

Methods: Our panel reviewed the medical literature in group meetings to reach a consensus on answering clinical questions related to the effects of the nutritional status, energy/protein intake recommendations, timing of enteral, and parenteral nutrition supplementation.

Results: Markers of the nutritional status of serum albumin, protein intake, and nitrogen balance had positive relationships with low mortality. A forest plot of the comparison of mortality between a body mass index (BMI) of <18.5 and ≥18.5 kg/m^2 was produced using data from seven observational studies which showed that a lower BMI was associated with higher mortality. The energy recommendation of 20–30 kcal/kg body weight (BW)/day was determined to be valid for all stages of AKI. The protein recommendation for noncatabolic AKI patients is 0.8–1.0 g/kg BW/day, and 1.2–2.0 g/kg BW/day is the same as that for the underlying disease that is causing AKI. Protein intake should be at least 1.5 g/kg BW/day and up to 2.5 g/kg BW/day in patients receiving continuous renal replacement therapy. Considering that patients with AKI often have other critical comorbid situations, early enteral nutrition (EN) is suggested, and parenteral nutrition is needed when >60% energy and protein requirements cannot be met via the enteral route in 7–10 days. Low energy intake is suggested in critically ill patients with AKI, which should gradually be increased to meet 80%–100% of the energy target.

Conclusion: By examining evidence-based research, we provide practicable nutritional guidelines for AKI patients.

Keywords: Acute kidney injury; Guidelines; Nutrition

1. INTRODUCTION

Around half of the patients in intensive care units (ICUs) experience acute kidney injury (AKI), and nearly 17% of those patients are treated with renal replacement therapy (RRT).[1] Malnutrition is highly prevalent among AKI patients and is an important independent predictor of in-hospital mortality.[2] AKI rarely is an isolated disease process, but most often is a complication of underlying conditions such as sepsis, trauma, or multiple-organ failure in critically ill patients. Nutrient requirements for patients with AKI thus may differ widely between individual patients and nutrition support must be coordinated with the metabolic consequences associated with renal failure, the underlying disease process, as well as the derangements in nutrient balance induced by RRT. General nutritional guidelines in ICUs lack specific recommendations for patients with AKI.[3] Guidelines from the American Society for Parenteral and Enteral Nutrition (ASPEN)[4] and the EEuropean Society for Clinical Nutrition and Metabolism (ESPEN)[5] still do not cover some clinical situations which need to be addressed. The effects of the nutritional status on outcomes, such as serum albumin, body mass index (BMI), nitrogen balance, and so on, have not been adequately clarified. Practicable supplies of protein and energy, the feeding amount in the first week after AKI occurs, and the nutrient administration still needs to be addressed by examining evidence-based studies. In this work, we systematically reviewed the literature and propose recommendations concerning the effects of the nutritional status, energy and protein intake, and timing of enteral and parenteral nutrition in critically ill patients with AKI.

2. METHODS

The Taiwan Acute Kidney Injury (TW-AKI) Consensus 2020 was established following the principles of evidence-based medicine (EBM), and the chosen topics were those covered in AKI guidelines or consensuses published by well-known academic and expert groups from various countries. The methodological details of the TW-AKI Consensus 2020 were recently reported.[6] In brief, the Nutrition Support for Acute Kidney Injury Consensus 2020 of Taiwan AKI Task Force is a group

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of dietitians, intensive care and trauma surgeons, intensive care physicians, and nephrologists who applied EBM through group meetings to reach consensuses. According to the Grading of Recommendations Assessment, Development and Evaluation (GRADE), the panel reviewed the medical literature, rated the certainty of evidence, and voted on the strength of recommendations. For each clinical question, the evidence grade and strength of the recommendation were provided and followed the rationale to explain the judgments.

3. RESULTS

3.1.1. Question

Q 1: Does the nutritional status affect the outcome of patients with AKI?

3.1.2. Recommendations

A 1.1: In adults with AKI, we suggest that serum albumin, protein intake, and nitrogen balance be used as predictors of mortality, with higher levels/intake associated with lower risks (1C).

A 1.2: In adults with AKI, we suggest that energy intake, and the BMI be used as predictors of mortality, with lower levels/intake associated with higher risks (2D).

3.1.3. Rationale

Critically ill patients with AKI are often suffering from multiple organ failure that complicates nutritional support. The nutritional status of critically ill patients affects plans for nutritional support. However, the effect of the nutritional status on the outcomes of patients with AKI is not yet clear. Assessments of the nutritional status include the BMI, serum albumin concentration, serum cholesterol level, muscle mass, subjective global assessment, nitrogen balance, and so on. In observational studies, surviving patients had higher serum albumin concentration.[7,8] According to a small number of observational studies, the survival rate increased for every increase of 1 g/dL of serum albumin.[9] AKI patients who required dialysis therapy had higher protein intake with lower mortality (0.8 vs. 0. 5 g/kg body weight (BW), p = 0.001);[9] the same result was observed in those who did not require dialysis (0.8 vs. 0.4 g/kg BW, $p < 0.001$).[8] In addition, higher nitrogen balance had lower mortality in AKI patients;[7] however, the results were not significant in patients who required dialysis.[9]

Lower energy intake was correlated with higher mortality as well (17.1 vs. 8.5 kcal/kg BW, $p < 0.001$),[8] and it is worth noting that the result was a single-day measurement 6 days after admission. Observational studies showed no statistically significant correlation between serum cholesterol and the mortality rate in patients with AKI.[7,8] Studies have shown that obesity was associated with an increased risk of developing AKI.[10–12] Paradoxically, obese patients seem to have a survival benefit compared to underweight or normal weight patients regardless of whether or not they required RRT.[10,11,13–15] Particularly in patients with more disease severity, high BMI patients (BMI ≥25 kg/m²) who required continuous RRT (CRRT) had a lower 30-day mortality rate; the effect was not observed in patients with less disease severity.[13] Nevertheless, patients with a BMI of ≥31 kg/m² had higher mortality, which was the same as those patients with a low BW (BMI <18 kg/m²).[15,16] For the elderly (aged more than 65 years), a multicenter retrospective analysis that included 2015 patients with AKI which occurred in ICUs after major surgery revealed that patients with a BMI of 21–31 kg/m² had lower in-hospital mortality.[15] Results of the forest plot demonstrated that AKI patients who have a lower BMI levels (<18.5 kg/m²) have a higher mortality risk than those with higher BMI (≥18.5 kg/m2) (Fig. 1). These data indicate that there is a U-shaped association of BMI with mortality in AKI patients. A summary of these articles on the nutritional status is given in Table 1.

3.2.1. Question

Q 2-0: What is appropriate energy recommendation for AKI treatment?

Q 2-1: Is the energy recommendation the same for AKI patients in different stages?

3.2.2. Recommendations

A 2-1: We suggest that the goal of total energy intake is to achieve 20–30 kcal/kg BW/day for all stages of AKI (1B).

3.2.3. Rationale

The energy requirement of patients with AKI is determined by the underlying disease and not by renal failure.[17–19] Studies and clinical guidelines suggest that indirect calorimetry (IC) can be used to measure energy requirements when available.[3,20,21] Sabatino et al.[22] showed that the average total energy expenditures (TEEs) of patients with AKI measured by IC were 1724 ± 431 kcal (about 20 kcal/kg actual BW) and about 1770 ± 431 kcal in ventilated patients (about 22 kcal/kg actual BW). Results of measurements from Allingstrup et al.[23] showed that the mean average was 28 kcal/kg actual BW (24–31.5 kcal/kg). Cheng et al.[24] measured energy expenditures of 46 mechanically ventilated, critically ill patients in an ICU in Taiwan, but without AKI, and found that the average value was 24.5 ± 8.6 kcal/kg actual BW as determined by IC. These observations indicate that the TEE of patients with AKI measured by IC is about 20–30 kcal/kg BW.

Study or Subgroup	BMI < 18.5 Events	BMI < 18.5 Total	BMI > = 18.5 Events	BMI > = 18.5 Total	Weight	Risk Ratio M-H, Random, 95% CI
Chao 2014	94	303	384	1712	17.7%	1.38 [1.14, 1.67]
Druml 2010	110	209	2888	5023	18.9%	0.92 [0.80, 1.04]
Kim 2018	70	99	632	1045	18.8%	1.17 [1.02, 1.34]
Nie 2017	33	133	162	1258	14.0%	1.93 [1.39, 2.68]
Pedersen 2017	24	104	152	1149	12.7%	1.74 [1.19, 2.55]
Zhang 2018	6	46	11	147	4.4%	1.74 [0.68, 4.45]
Zou 2017	32	254	202	2749	13.5%	1.71 [1.21, 2.43]
Total (95% CI)		**1148**		**13083**	**100.0%**	**1.39 [1.11, 1.73]**
Total events	369		4431			

Heterogeneity: Tau² = 0.06; Chi² = 35.43, df = 6 (P < 0.00001); I² = 83%
Test for overall effect: Z = 2.91 (P = 0.004)

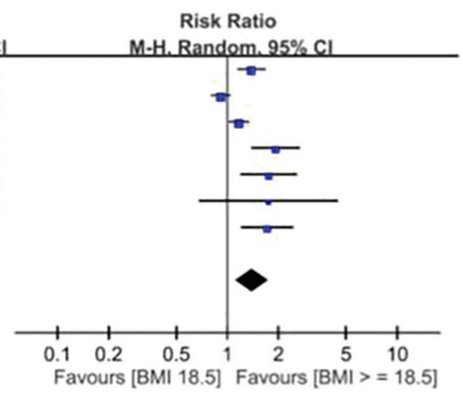

Fig. 1 Forest plot of a comparison of mortality between patients with a body mass index (BMI) of <18.5 kg/m² and those with a BMI of ≥18.5 kg/m².

Table 1

Effect of the nutritional status on outcomes of patients with acute kidney injury

Study	Design	Population	Summary results
Berbel et al.[6]	Prospective observational study	133 patients with a clinical diagnosis of AKI. Excluded patients <18 years old, those requiring chronic renal replacement therapy (dialysis or transplantation), or those with a baseline serum creatinine of >4 mg/dL.	Low energy intake, higher C-reactive protein levels, edema, lower resistance measured by a bioelectrical impedance analysis, and nitrogen balance were significantly associated with mortality in AKI patients.
Kawarazaki et al.[7]	Multicenter retrospective observational study of ICUs	Adult patients with AKI requiring CRRT admitted to participating ICUs (n = 343) were included.	High urine output, low SOFA scores, and a short time from ICU admission to RRT initiation were independently related to early renal recovery. High serum lactate, low serum albumin, vasopressor use, and neurological disease were closely related to early death.
Bufarah et al.[8]	Prospective observational study.	595 adult patients with AKI requiring enteral or parenteral feeding. Caloric and protein intake and nitrogen balance were recorded on the first day of referral to the nephrologist.	Low caloric and protein intake, a negative nitrogen balance, and low serum albumin were associated with higher in-hospital mortality.
Kritmetapak et al.[9]	Prospective observational study.	70 critically ill patients requiring CRRT in the ICU.	Dietary protein intake was a good predictor of survival. The serum albumin level was a good prognosticator of renal outcomes.
Druml et al.[10]	Prospective multicenter study of AKI patients in the ICU.	5232 patients with AKI requiring RRT.	Obesity was an independent risk factor for developing AKI. Mortality followed a U-shaped pattern, with the lowest mortality rate in obese patients (30 ≤BMI ≤35).
Zou et al.[11]	Retrospective study.	A total of 8455 patients underwent cardiac surgery; 2855 patients developed AKI; 148 patients required RRT.	The AKI incidence rate increased with a higher BMI. The in-hospital mortality of AKI-RRT patients was lowest in those with a BMI in the range of 24–28 kg/m^2.
Pedersen et al.[12]	Prospectively collected data from regional medical databases.	Patients who underwent surgery to repair a hip fracture in 2005–2011 were included. The cumulative risks of AKI by the BMI level during 5 days post-surgery and subsequent short-term (6–30 days post-surgery) and long-term (31–365 days post-surgery) mortality were calculated.	Obese patients had a higher risk of developing AKI. Regardless of whether AKI occurred; underweight patients had elevated mortality for up to 1 year after hip fracture surgery compared to normal-weight patients. All BMI groups with the presence of AKI had higher mortality.
Kim et al.[13]	Observational study.	1144 patients undergoing CRRT due to AKI.	AKI patients with a higher BMI had higher survival rates especially those with greater disease severity, but the effect was not observed in those with less-severe disease.
Nie et al.[14]	Retrospective study.	1387 AKI patients.	Factors affecting the mortality of AKI patients included a high AKI stage, ≥80 years of age, neoplastic disease, low cardiac output, an increased white blood cell count, and a low platelet count and serum albumin level. In contrast, BMI of 28–34.9 kg/m^2 was a protective factor.
Chao et al.[15]	Retrospective and prospective multicenter observational cohort.	2015 elderly patients (aged ≥65 years) who developed AKI after major surgery in the ICU.	AKI patients (21 ≤BMI<35) had a lower mortality risk. There was a U-shaped association of BMI with hospital mortality in elderly AKI patients.
Zhang et al.[16]	Retrospective study.	193 critically ill patients with acute renal failure were included. Malnutrition was defined as having a BMI of <18.5 or unintentional weight loss of >4.5 kg for adults, and BMI of <20 kg/m^2 or unintentional weight loss of >4.5 kg for the elderly (aged ≥65 years).	The 1-year mortality was significantly higher in those patients with malnutrition than those without malnutrition, but there was no significant difference in in-hospital survival between the two groups.

AKI = acute kidney injury; BMI = body mass index (kg/m^2); CRRT = continuous renal replacement therapy; ICU = intensive care unit; RRT = renal replacement therapy; SOFA = sequential organ failure assessment.

Furthermore, in a crossover study by Fiaccadori et al.[25] comparing the provision of 30 and 40 kcal/kg BW/day energy, they demonstrated that a higher energy intake did not induce a more positive nitrogen balance but was associated with higher incidences of hyperglycemia, hypertriglyceridemia, fluid overload, and increased insulin use in AKI patients. Previous research showed that no predictive equations are precise enough, and about 70% of differences between IC measurements and predictive equations exceeded ±10%, and simplistic weight-based equations provided a sufficient estimate.[22,24,26] Thus, predictive equations usually are not used to estimate energy requirements in current clinical guidelines. The Kidney Disease: Improving Global Outcomes (KDIGO) 2012 Guidelines suggest achieving a total energy intake of 20–30 kcal/kg BW/day in patients at any stage of AKI.[27] The Society of Critical Care Medicine (SCCM) and ASPEN 2016 Critically ill Guidelines using a weight-based equation suggested 25–30 kcal/kg BW/day for ICU patients with AKI.[4] Therefore, when IC is unavailable, we suggest that the goal of total energy intake should achieve 20–30 kcal/kg BW for all stages of AKI. Patients with a normal weight and those underweight should use the usual BW or edema-free actual BW, and the ideal BW (IBW) should be used for overweight (BMI 25–30 kg/m^2) patients. The reasons are as follows: Use of the actual BW will over-predict energy requirements when patients are overweight and under-predict them for underweight patients. Using the IBW will cause an overestimation of the energy provision for underweight patients and may cause an underestimation in obese patients. However, carbohydrate metabolism in AKI is characterized by hyperglycemia due to insulin resistance from inflammatory mediators and counter-regulatory hormones.[20] Furthermore, energy requirements may be difficult to meet in clinic practice. Therefore, based on an expert consensus, we suggest that for all classes of obesity, the same as the SCCM and ASPEN 2016 guidelines, to use the weight-based equation 11–14 kcal/kg actual BW per day for patients with a BMI in the range of 30–50 kg/m^2 and 22–25 kcal/kg IBW per day for patients with a BMI of >50 kg/m^2.

As to the desired amounts of energy administration according to the KDIGO recommendations, energy provision should be composed of 3–5 (maximum 7) g/kg BW of carbohydrates and 0.8–1.0 g/kg BW of fat. In addition, previous research showed that lower caloric intake was associated with higher hospital mortality in AKI-CRRT patients.[8,28,29] The Randomized Evaluation of Normal versus Augmented Level (RENAL) Replacement Therapy Study, a multicenter randomized controlled trial of critically ill AKI-CRRT patients, which assessed delivery of caloric intake between survivors and nonsurvivors showed that a very low caloric intake (<10–11 kcal/kg BW/day), caloric intake was not associated with mortality.[28] However, results of a prospective observational study by Bufarah et al.[8] in 595 critically ill patients with AKI showed that low caloric intake was associated with higher hospital mortality. Dietary calorie and protein intake levels were significantly higher in the surviving group compared to the nonsurviving group. The mean caloric intake of survivors was 17.1 kcal/kg BW, and it was 8.5 kcal/kg BW for nonsurvivors. Analysis of the area under the receiver operating characteristic curve showed that calorie intake of <12 kcal/kg BW was a predictor of hospital mortality. These results are consistent with the findings of Berbel et al. which showed that the caloric intake of survivors was 12.9 kcal/kg BW and it was 7.2 kcal/kg BW for nonsurvivors. Thus, we suggest that caloric intake of at least 12 kcal/kg BW/day is required to improve clinical outcomes and reduce hospital mortality.[29]

3.2.4. Question

Q 2-2: Does the energy requirement differ for AKI patients receiving CRRT?

3.2.5. Recommendations

A 2-2: The energy expenditure of AKI patients is not affected by CRRT. The energy requirement of AKI with CRRT is the same as that for patients without dialysis[22,26] (1B).

3.3.1. Question

Q 3-0: What is the appropriate protein recommendation for AKI treatment?

Q 3-1: Are protein recommendations the same for AKI patients in different stages?

3.3.2. Recommendations

A 3-1: The protein requirement of patients with AKI is determined by the underlying disease causing the AKI, the extent of catabolism, and the type of treatment. We suggest prescribing a dietary protein intake of 0.8–1.0 g/kg BW/day for noncatabolic AKI patients (e.g., dehydration, obstructive uropathy, medication-induced nephrotoxicity, etc). In critically ill patients, we suggest administering 1.2–2.0 g/kg BW/day of protein the same as with the underlying disease causing the AKI. Protein intake should be increased when patients undergo dialysis (2C).

3.3.3. Rationale

Nutritional requirements of patients with AKI are not determined by AKI per se but are related to the primary disease and any comorbidity. The severity of kidney injury affects the elimination of the daily production of metabolic wastes and nutrients lost due to dialysis treatment. Hypovolemia causing noncatabolic AKI is common in older and malnourished patients which may result from dehydration, upper gastrointestinal bleeding, congestive heart disease, and hypoalbuminemia. Since hypoalbuminemia is associated with effective hypovolemia and increases mortality in these patients, nutritional management should aim at supplying sufficient protein to maintain the serum albumin concentration and immune function.[30] Hence, nutritional protein administration should not be restricted to attenuating the rise in blood urea nitrogen or delaying initiation of dialysis. Therefore, based on an expert consensus, we suggest, identical to the KDIGO 2012 guidelines, to prescribe a dietary protein intake of 0.8–1.0 g/kg BW/day for noncatabolic AKI patients. In critically ill patients, we suggest that, identical to the SCCM and ASPEN 2016 guidelines, administering 1.2–2.0 g/kg BW/day of protein as determined by the underlying disease such as sepsis, trauma, burn, or multiple-organ failure. The protein intake should be increased when patients undergo RRT.

3.3.4. Question

Q 3-2: Is the protein requirement different for AKI patients receiving CRRT?

3.3.5. Recommendations

A 3-2: We suggest administering at least 1.5 g/kg BW/day of protein and up to 2.5 g/kg BW/day in patients receiving CRRT (2C).

3.3.6. Rationale

Previous research showed that about 10–15 g of amino acids and 5–10 g of protein are lost per day in AKI patients treated with CRRT which translates to an equivalent protein loss of 0.2 g/kg BW/day. Protein losses range widely from 5% to 20% of amino acid intake depending on the type of therapy and dialyzer membrane.[20,31–35] Studies which estimated protein requirements by the presence of total nitrogen showed that the normalized protein catabolic rate (nPNA) was 1.4 g/kg BW when being treated with sustained low-efficiency dialysis (SLED)[36] and the mean nPNA was 1.7 g/kg BW with CRRT.[37,38] Those studies indicated that the nitrogen balance was related to protein intake and was more likely to benefit from intake exceeding 1.5 g/kg BW/day,[23,37,38] and a positive nitrogen balance can be achieved by providing a protein intake of 2.5 g/kg BW/day in critically ill patients with AKI-CRRT.[26,33,34] Thus, we suggest administering at least 1.5 g/kg BW/day of protein and up to 2.5 g/kg BW/day in patients receiving CRRT. This recommendation is higher than the KDIGO 2012 guideline of 1.0–1.5 g/kg BW/day in patients with AKI on RRT, and up to a maximum of 1.7 g/kg BW/day in patients on CRRT, but is the same as the SCCM and ASPEN 2016 guidelines. In addition, studies showed that protein intake is associated with mortality in patients with AKI.[8,9,29,39] Results of the RENAL study showed that there was no significant difference in protein intake between survivors and nonsurvivors when the protein intake was less than 0.5g/kg BW/day.[39] However, a study by Bufarah et al.[8] showed that low protein intake was associated with higher hospital mortality. The mean protein intake of survivors was 0.8 g/kg BW, and that of nonsurvivors was 0.4 g/kg BW. Analysis of the receiver operating characteristic curve showed that protein intake of <0.5 g/kg BW increased hospital mortality.[8] The results are consistent with the findings of Berbel et al.,[29] which showed that protein intake levels were 0.54 g/kg BW for survivors and 0.3 g/kg BW for nonsurvivors. Thus, we suggest that protein intake of at least 0.5 g/day is required to improve clinical outcomes and reduce hospital mortality.

3.4.1. Question

Q 4-0: Should full-energy enteral nutrition be given to critical adult patients with AKI?

3.4.2. Recommendations

A 4-0 a: Early enteral nutrition should be given within 48 hour (2C).

A 4-0 b: It is not recommended to give full-energy nutrition in the acute phase of the illness. After the acute phase, 72 hour later, energy can be stepwise increased to meet 80%–100% of the feeding goal (2C).

A 4-0 c: For patients who cannot eat by mouth, early enteral nutrition should be given instead of parenteral nutrition (1B).

3.4.3. Rationale

Energy requirements of patients with AKI are determined by the underlying disease (as referred to in Q 2-0), and targeted nutritional support is the personalized adjustment of nutritional formulas.[40] According to 2019 guidelines of the European Society for Clinical Nutrition and Metabolism (ESPEN) and 2016 guidelines of the ASPEN for critically ill patients,[2,3] an assessment of the nutritional status should be performed for all patients in the ICU. In the first week, standard nutritional therapy of oral intake and general infusion containing glucose are suggested for critically ill patients with AKI who are at low nutritional risk (Nutritional Risk Screening [NRS] 2002 score of ≤3 or Nutrition Risk in Critically Ill (NUTRIC) score of ≤5).[41,42] For those who are at high nutritional risk (NRS 2002 score of >3 or NUTRIC score of >5), enteral nutrition or parenteral nutrition is suggested within 24–48 hour of ICU admission. AKI patients at high nutritional risk who received early enteral nutrition (within 48 hour) had a significantly lower mortality rate compared to those who received late enteral nutrition.[3] Enteral nutrition should be delivered in the first 24–48 hour of an ICU stay if there are no contraindications. Parenteral nutrition should be given if, after 7–10 days, enteral nutrition is unable to meet 60% of the energy requirement. Two large randomized controlled trials that focused on critically ill patients who required mechanical ventilation showed that those who received early enteral nutrition had significantly higher complications of vomiting, diarrhea, and ischemic bowel, but they also had shorter ICU stays and fewer in-hospital days, compared to those who received early parenteral nutrition. Nevertheless, the results of the two clinical studies presented no significant difference in overall mortality between the two types of nutritional support.[43,44] Following the 2019 ESPEN guidelines, critically ill patients with AKI should receive early enteral nutrition rather than parenteral nutrition.[2] In a randomized study, patients on the fourth day in the ICU began enteral nutrition combined with parenteral nutrition to meet 100% of their energy requirements, and this reduced hospital-acquired infections better than did a step-wise increase in enteral nutrition.[45]

AKI patients in the ICU are in a hypermetabolic state because of systemic inflammatory response syndrome (SIRS) and the release of cytokines. A meta-analysis of randomized controlled trials indicated that initial high-energy intake could increase the infection rate, hospital-acquired pneumonia, gastrointestinal intolerance, and days on mechanical ventilation. Furthermore, patients in the initial moderate-energy intake group (33.3%–66.6% of target energy) had lower mortality compared to the high-energy intake group.[46] Two clinical trials compared trophic feeding with full-feeding nutrition for the first 6 days in acute lung injury patients on ventilator support. Those results agreed that the two feeding strategies had no difference in ventilator-free days, ICU-free days, or mortality.[47,48] However, the trophic feeding group had less gastrointestinal intolerance[47,48] and insulin use, and lower plasma glucose levels.[48] Hence, we suggest that trophic feeding be given to critical patients with AKI to preserve the intestinal mucosa and enteric function. The definition of trophic feeding is to give enteral nutrition at 10–20 kcal/h or up to 500 kcal/day.[43] In conclusion, for critically ill patients with AKI, begin feeding with a low-energy diet or a full-energy diet if the effect of mortality is still controversial. However, initial trophic feeding can reduce episodes of gastrointestinal intolerance.

3.5.1. Question

Q 5-0: Is a parenteral nutrition intervention indicated for critically ill patients with AKI?

Q 5-1: What is the timing of the parenteral nutrition intervention for critically ill patients with AKI?

3.5.2. Recommendations

A 5-1: Delayed parenteral nutrition support is recommended when AKI patients are receiving enteral nutrition (2C).

3.5.3. Rationale

Parenteral nutrition is an important part of an overall nutritional plan. Desired parenteral nutrition is given after evaluating the current nutritional status, including oral intake, enteral nutrition, nutritional risk, and medical status. Parenteral nutrition should be reevaluated and adjusted whenever necessary based on a patient's status and medical treatments. In general, parenteral nutrition is initiated when there is a contraindication for enteral nutrition or inadequate intake due to intolerance of enteral nutrition. Integrated nutritional support can decrease complications of malnutrition and improve outcomes.[49]

To meet the energy and protein target, either central parenteral nutrition or peripheral parenteral nutrition to complement insufficient oral intake or inadequate enteral nutrition is recommended. However, parenteral nutrition should gradually be decreased with increasing oral intake or enteral nutrition based on the energy requirement and to avoid overnutrition.[50]

Timing of the parenteral nutrition intervention can be categorized by the nutritional risk because of the role of parenteral nutrition is to complement enteral nutrition.[3,51] Low nutritional risk: Patients with an NRS 2002 score of ≤3 or a NUTRIC score of ≤5 has enough energy storage during the acute phase of a critical illness. Parenteral nutrition will not be necessary in the first week even if patients suffer from inadequate oral intake or enteral nutrition. High nutritional risk: In patients who fail to begin enteral nutrition with an NRS 2002 score of >3 or a NUTRIC score of >5, or have a severe malnutrition status, parenteral nutritional intervention should be begun as soon as possible. An intervention of parenteral nutrition after 7–10 days of inadequate enteral nutrition is feasible.

Factors related to the timing of the parenteral nutritional intervention include nutrition risk, energy and protein requirements, tolerance of enteral nutrition, and infection risk. The supplemental use of parenteral nutrition, when enteral nutrition does not meet the nutritional requirements, may improve provision of calories and protein but is not associated with better clinical outcomes compared to enteral nutrition alone.[52,53] Recent data from a large randomized multicenter trial which included 4640 patients with high nutritional risk showed that late parenteral nutrition (given on day 8) was associated with fewer infections, enhanced recovery, and lower health care costs compared with early parenteral nutrition (given within 48 hour).[54] Hence, with the exception of patients at high nutritional risk, late parenteral nutrition intervention is safe and acceptable.

4. DISCUSSION

In conclusion, because patients with AKI often have other serious diseases, nutritional support should be considered in a holistic manner. Through the process of evaluating evidence-based research, we provide practicable nutritional guidelines for clinicians and dietitians to make decisions when caring for AKI patients.

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