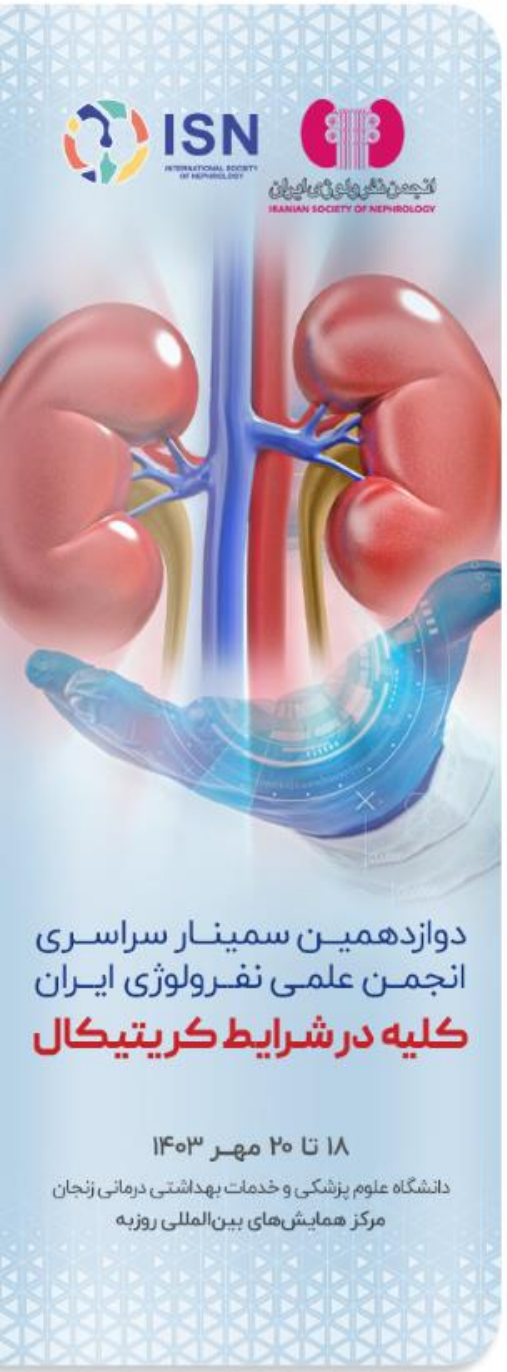
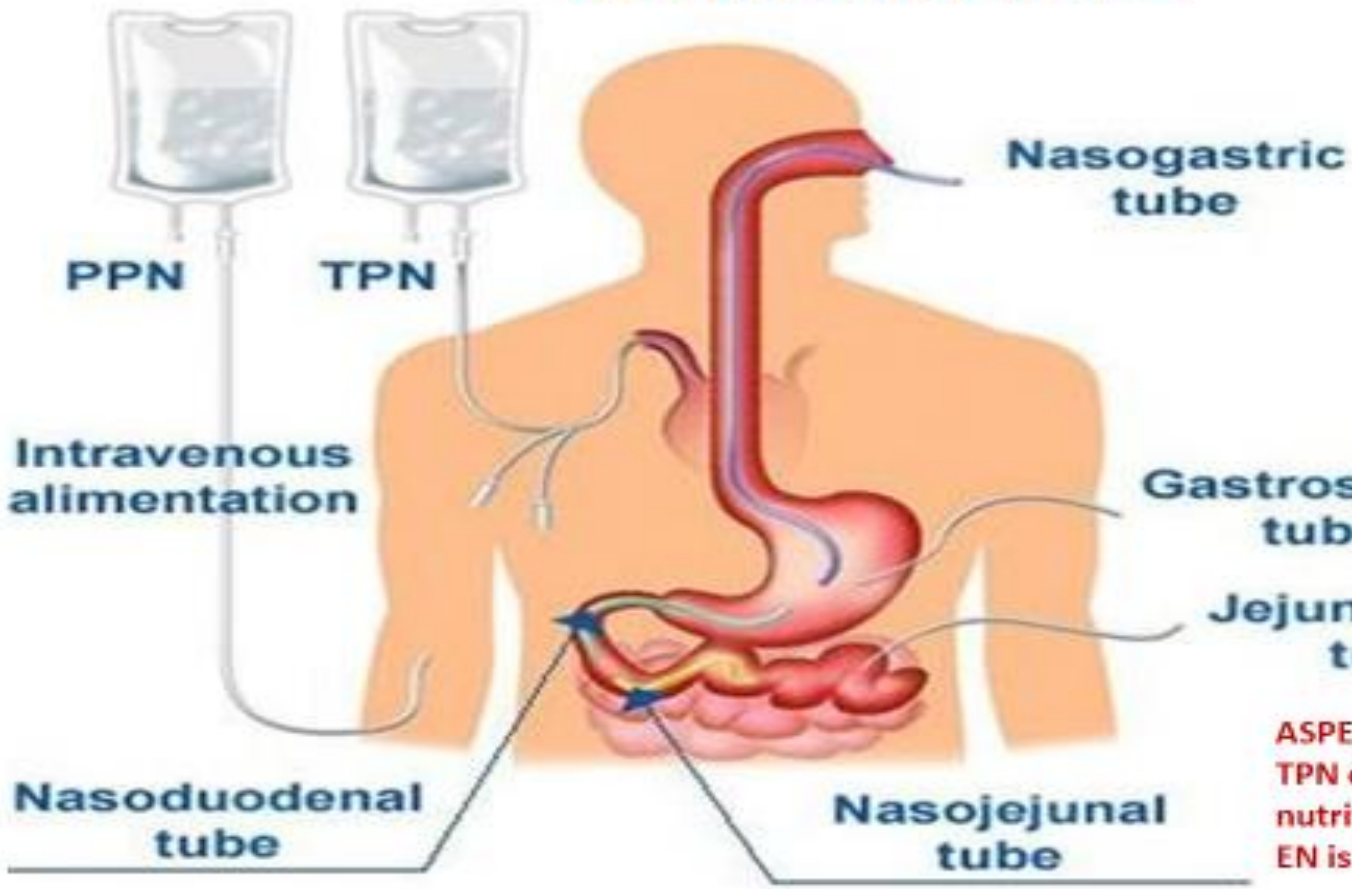


Total Parenteral Nutrition (TPN)

Tahereh Malakoutian , M.D
Iran University of Medical sciences

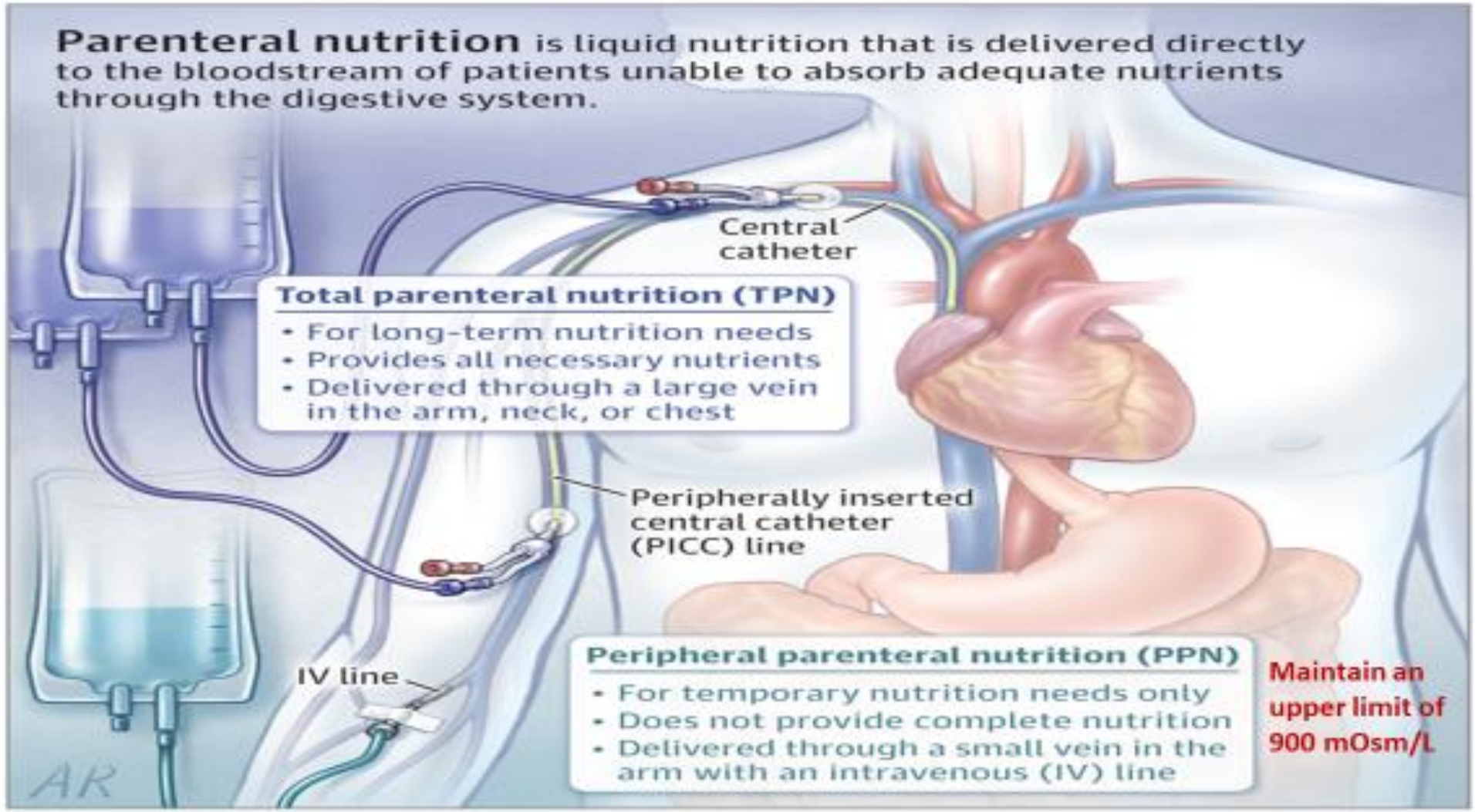
FEEDING METHODS



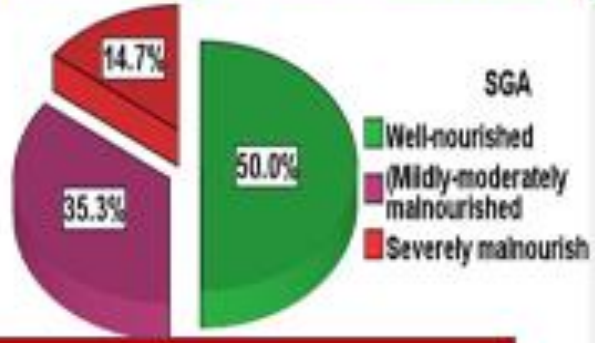
1. Enteral: Po , NGT/OGT- NJT , PEG , Jejenostomy

2.Parenteral: PPN, TPN

ASPEN and the ESPEN recommend TPN or SPN as a second choice of nutrition support and only if the use of EN is deemed impractical


Parenteral nutrition is liquid nutrition that is delivered directly to the bloodstream of patients unable to absorb adequate nutrients through the digestive system.
Central catheter
Total parenteral nutrition (TPN)
• For long-term nutrition needs
• Provides all necessary nutrients
• Delivered through a large vein in the arm, neck, or chest
Peripherally inserted central catheter (PICC) line
IV line
Peripheral parenteral nutrition (PPN)
• For temporary nutrition needs only
• Does not provide complete nutrition
• Delivered through a small vein in the arm with an intravenous (IV) line
Maintain an upper limit of 900 mOsm/L
AR

EN is usually the main route for providing nutrition therapy in patients admitted to the ICU.PN may be needed to avoid the development of malnutrition when EN is contraindicated or unfeasible



Nutritional status of the studied medical ICU patients according to SGA

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International Journal of Internal Medicine
p-ISSN: 2326-1064 e-ISSN: 2326-1072
2018; 7(4): 54-59
doi:10.5923/j.ijim.20180704.02

Abstract
Reference
Full-Text PDF
Full-text HTML

Prevalence of Malnutrition among Hospitalized Medical Intensive Care Unit Patients in a University Hospital, Cairo, Egypt: Hospital Based Survey

Doaa S. D. Zaki[1], Doaa M. Zakaria[1], Heba M. Abd El-Galil[2]

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[2]Department of Community Medicine and Occupational Health, Al-Azhar University, Cairo, Egypt

Correspondence to: Doaa S. D. Zaki, Department of Internal Medicine, Al-Zahraa University Hospital, Al-Azhar University, Cairo, Egypt.
Email: dsalah241@azhar.edu.eg

Abstract

Background/Aims: Malnutrition in critically ill adults in the intensive care unit (ICU) is a serious public health problem that has been associated with a significantly elevated risk of infectious and non-infectious complications. This study aimed to estimate the prevalence of malnutrition among adult patients admitted to medical ICU. Methods: This was a hospital based prospective cross-sectional study carried out for 3 months in medical ICU of the internal medicine ward in AL-Zahra University hospital, Cairo, Egypt. Patients were evaluated for the nutritional status by using subjective global assessment (SGA) within the first 24 hours of admission. Results: A total of 68 patients were participated in the study (61.1±13.3 years; 54.4% females). According to SGA, 90% of ICU patients were malnourished either mild/moderate (35.3%) or severely malnourished (14.7%). Malnourished patients had a mortality rate of (55.9%) versus well-nourished group (26.5%). Conclusions: Malnutrition was highly prevalent among critically ill patients in medical ICU and increased the risk of mortality. Nutritional screening is mandatory in ICU sitting to initiate timely nutritional therapy.

Review

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SAGE

Association Between Malnutrition and Clinical Outcomes in the Intensive Care Unit: A Systematic Review

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2016 : 20 Of 1168 studies , this is the first systematic review to demonstrate an association between malnutrition and clinical outcomes in the ICU using validated nutrition assessment tools

Abstract

Malnutrition is associated with poor clinical outcomes among hospitalized patients. However, studies linking malnutrition with poor clinical outcomes in the intensive care unit (ICU) often have conflicting findings due in part to the inappropriate diagnosis of malnutrition. We primarily aimed to determine whether malnutrition diagnosed by validated nutrition assessment tools such as the Subjective Global Assessment (SGA) or Mini Nutritional Assessment (MNA) is independently associated with poorer clinical outcomes in the ICU and if the use of nutrition screening tools demonstrate a similar association. PubMed, CINAHL, Scopus, and Cochrane Library were systematically searched for eligible studies. Search terms included were synonyms of *malnutrition*, *nutritional status*, *screening*, *assessment*, and *intensive care unit*. Eligible studies were case-control or cohort studies that recruited adults in the ICU; conducted the SGA, MNA, or used nutrition screening tools before or within 48 hours of ICU admission; and reported the prevalence of malnutrition and relevant clinical outcomes including mortality, length of stay (LOS), and incidence of infection (IOI). Twenty of 1168 studies were eligible. The prevalence of malnutrition ranged from 38% to 78%. Malnutrition diagnosed by nutrition assessments was independently associated with increased ICU LOS, ICU readmission, IOI, and the risk of hospital mortality. The SGA clearly had better predictive validity than the MNA. The association between malnutrition risk determined by nutrition screening was less consistent. Malnutrition is independently associated with poorer clinical outcomes in the ICU. Compared with nutrition assessment tools, the predictive validity of nutrition screening tools were less consistent. (*JPEN J Parenter Enteral Nutr*. XXXX;xx:xx-xx)

Clinical Nutrition 38 (2019) 48–79

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ESPEN Guideline

ESPEN guideline on clinical nutrition in the intensive care unit

Pierre Singer [a, *], Annika Reintam Blaser [b, c], Mette M. Berger [d], Waleed Alhazzani [e], Philip C. Calder [f], Michael P. Casaer [g], Michael Hiesmayr [h], Konstantin Mayer [i], Juan Carlos Montejo [j], Claude Pichard [k], Jean-Charles Preiser [l], Arthur R.H. van Zanten [m], Simon Oczkowski [e], Wojciech Szczeklik [n], Stephan C. Bischoff [o]

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[c] Department of Intensive Care Medicine, Lucerne Cantonal Hospital, Lucerne, Switzerland
[d] Service of Adult Intensive Care and Burns, Lausanne University Hospital, Lausanne, Switzerland
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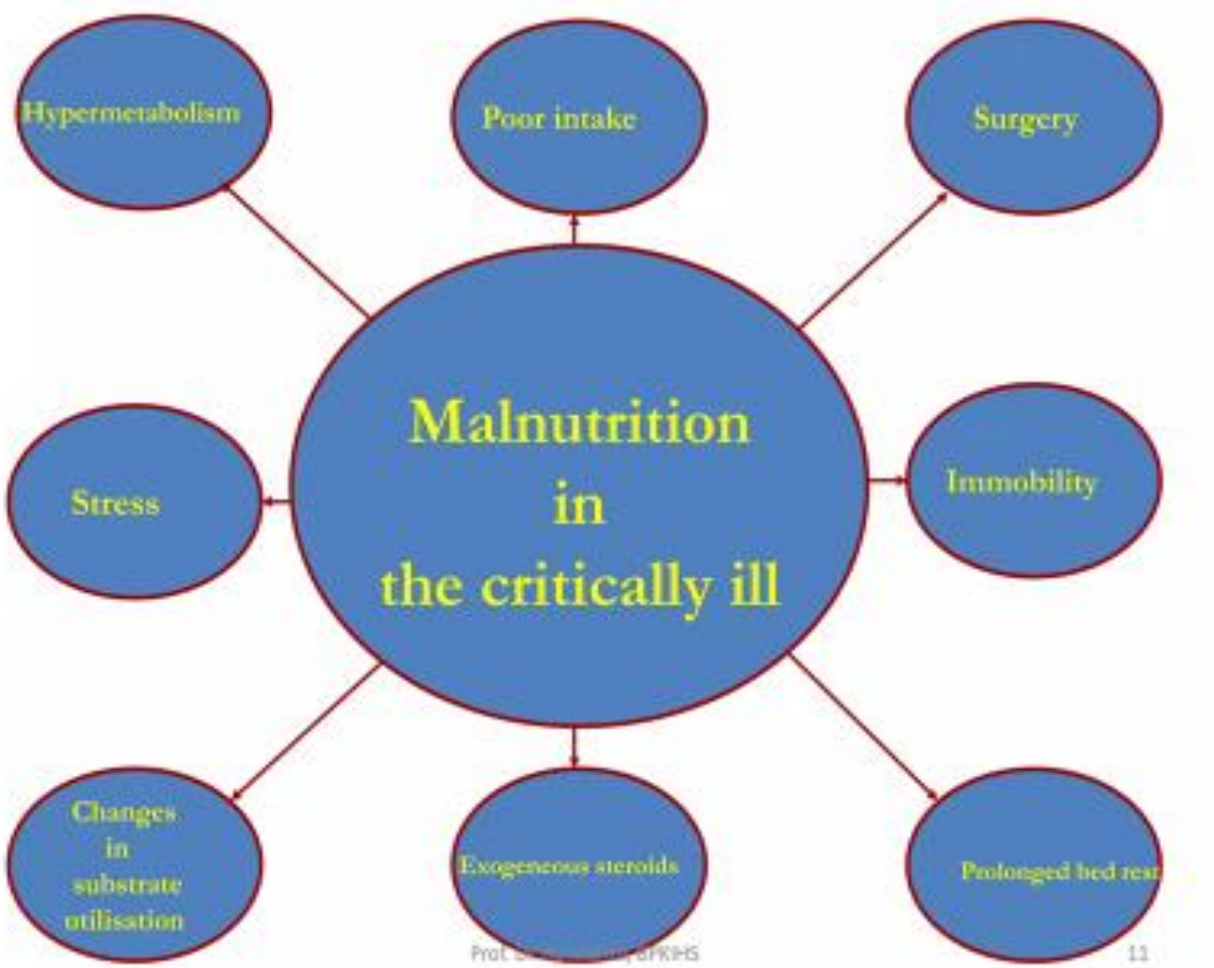
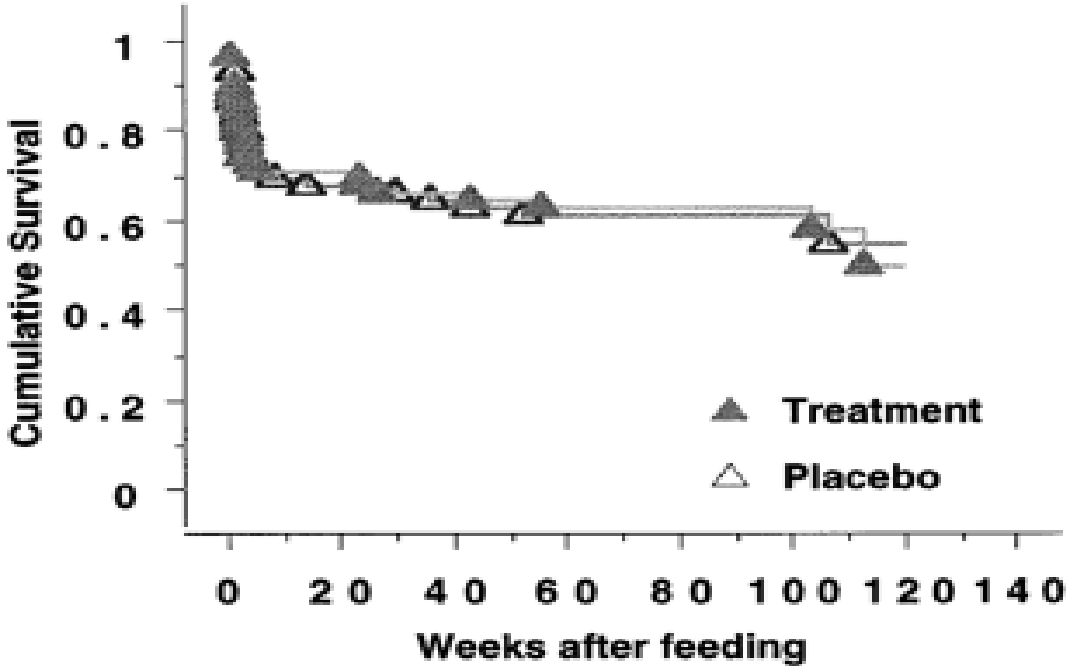
[f] Human Development and Health Academic Unit, Faculty of Medicine, University of Southampton and NIHR Southampton Biomedical Research Centre, University Hospital Southampton NHS Foundation Trust, Southampton, United Kingdom
[g] Clinical Department and Laboratory of Intensive Care Medicine, Catholic University Hospitals (UZLeuven) and Catholic University Leuven, Leuven, Belgium

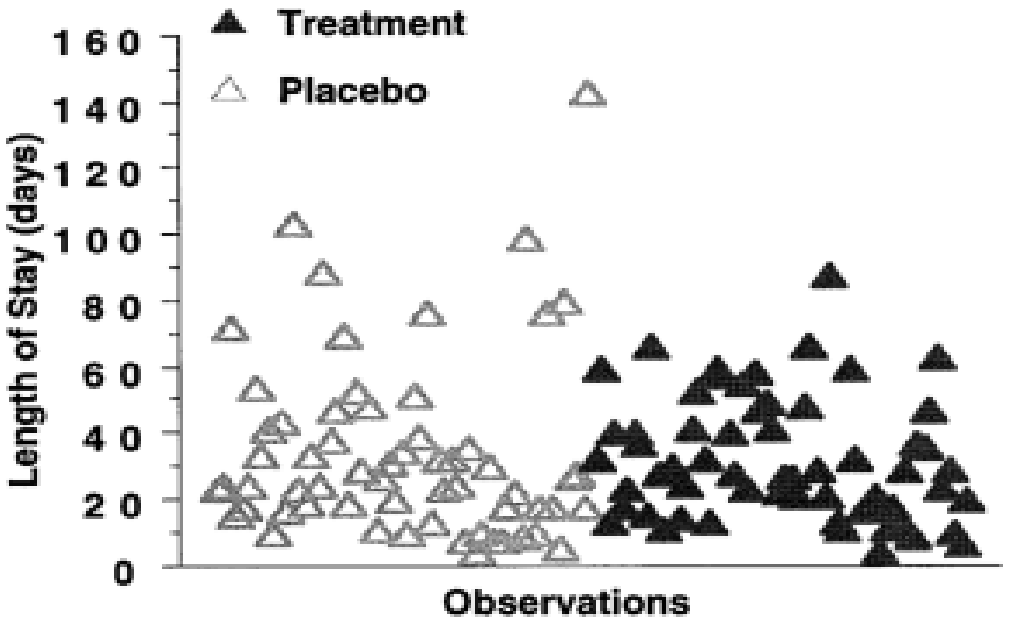
large heterogeneity of the ICU population
potentially reduces the external validity of the recommendations

Types of Patients in the ICU	Prevalence of Malnutritic
Heterogeneous group[8,20,21,23,26-32]	37.8%–78.1%
Elderly[34]	23.2%–34.4%
Cardiac surgery[22]	5.0%–20.0%
Liver transplantation[26,27]	52.6%
Acute kidney injury[39]	82.0%





Kaplan-Meyer estimates of cumulative survival in treatment and placebo groups . Difference between two groups were not significant



Length of stay in hospital. P value : 0.0022

P Bauer. Intensive Care Medicine 2000

Elke et al. Critical Care (2016) 20:117
DOI 10.1186/s13054-016-1298-1

Critical Care

RESEARCH

Open Access

Enteral versus parenteral nutrition in critically ill patients: an updated systematic review and meta-analysis of randomized controlled trials

Gunnar Elke[1], Arthur R. H. van Zanten[2], Margot Lemieux[3], Michele McCall[4], Khursheed N. Jeejeebhoy[5], Matthias Kott[1], Xuran Jiang[3], Andrew G. Day[3] and Daren K. Heyland[3*]

2016 ;EN has **no effect on mortality but decreases infectious complications and ICU LOS : 18 RCTs , 3347 patients**

Abstract

Background: Enteral nutrition (EN) is recommended as the preferred route for early nutrition therapy in critically ill adults over parenteral nutrition (PN). A recent large randomized controlled trial (RCT) showed no outcome differences between the two routes. The objective of this systematic review was to evaluate the effect of the route of nutrition (EN versus PN) on clinical outcomes of critically ill patients.

Methods: An electronic search from 1980 to 2016 was performed identifying relevant RCTs. Individual trial data were abstracted and methodological quality of included trials scored independently by two reviewers. The primary outcome was overall mortality and secondary outcomes included infectious complications, length of stay (LOS) and mechanical ventilation. Subgroup analyses were performed to examine the treatment effect by dissimilar caloric intakes, year of publication and trial methodology. We performed a test of asymmetry to assess for the presence of publication bias.

Results: A total of 18 RCTs studying 3347 patients met inclusion criteria. Median methodological score was 7 (range, 2–12). No effect on overall mortality was found (1.04, 95 % CI 0.82, 1.33, $P = 0.75$, heterogeneity $I^2 = 11$ %). EN compared to PN was associated with a significant reduction in infectious complications (RR 0.64, 95 % CI 0.48, 0.87, $P = 0.004$, $I^2 = 47$ %). This was more pronounced in the subgroup of RCTs where the PN group received significantly more calories (RR 0.55, 95 % CI 0.37, 0.82, $P = 0.003$, $I^2 = 0$ %), while no effect was seen in trials where EN and PN groups had a similar caloric intake (RR 0.94, 95 % CI 0.80, 1.10, $P = 0.44$, $I^2 = 0$ %; test for subgroup differences, $P = 0.003$). Year of publication and methodological quality did not influence these findings; however, a publication bias may be present as the test of asymmetry was significant ($P = 0.003$). EN was associated with significant reduction in ICU LOS (weighted mean difference [WMD] -0.80, 95 % CI −1.23, −0.37, $P = 0.0003$, $I^2 = 0$ %) while no significant

Effect of combined parenteral and enteral nutrition versus enteral nutrition alone for critically ill patients

A systematic review and meta-analysis

receiving EN alone decreased the respiratory infections and length of days at hospital (8 RCT , 5300 patients)

Jialing Shi[a], Liying Wei[a], Rongzhi Huang[a], Liang Liao[b,*]

Abstract

Background and aim: The increased mortality rate and other poor prognosis make malnutrition a serious issue for adult critically ill patients in intensive care unit care. This study was to compare outcomes between combined parenteral and enteral nutrition and enteral nutrition alone for adult critically ill patients.

Materials and methods: The PubMed (June 30st, 2018), EMBASE (June 30st, 2018), and Cochrane library databases (June 30st, 2018) were searched systematically. Randomized controlled trials (RCTs) of comparing combined PN and EN with EN alone were eligible. Relative risks (RRs), mean differences (MDs), and 95% confidence intervals (CIs) were calculated for dichotomous and continuous outcomes.

Results: Eight RCTs involving 5360 patients met the inclusion criteria. Compared with combined PN and EN, fewer respiratory infections (RR, 1.13 [95% CI 1.01–1.25]) and shorter length of days at hospital (MD, 1.83 [95% CI 1.05–2.62]) were observed in EN alone group. And no significant differences were found on hospital mortality (RR, 0.91 [95% CI 0.74–1.12]), length of days in ICU (MD, −0.23 [95% CI −1.79 to 1.32]), duration of ventilatory support (MD, −1.10 [95% CI −3.15 to 0.94]), albumin (MD, −0.04 [95% CI, −0.12 to 0.21]), or prealbumin (MD, −0.77 [95% CI −0.22 to 1.75]) between theses 2 groups.

Conclusion: Receiving EN alone decreased the respiratory infections and length of days at hospital for critically ill patients. Combined PN and EN did not add up the potential risk from PN and EN on hospital mortality, length of days in ICU, duration of ventilatory support, albumin, and prealbumin.

Abbreviations: CI = confidence interval, EN = enteral nutrition, ICU = intensive care unit, MD = mean differences, NR = not reported, PN = parenteral nutrition, PN+EN = combined parenteral and enteral nutrition, RCTs = randomized controlled trial, RR = relative risk, SD = standard deviation, STBI = severe traumatic brain injury.

Keywords: enteral nutrition, intensive care unit, meta-analysis, parenteral nutrition

1. Introduction

Nearly 40% of adult critically ill patients have a high risk of malnutrition,[1] which definitely increases the incidence of

supplements have become important and necessary. In general, the individual benefits and risks of parenteral nutrition (PN) and enteral nutrition (EN) have been elucidated gradually. Because of cheaper, safer, and more physiologic, EN remains the preferred

DOI: 10.1002/jpen.2125

ORIGINAL COMMUNICATION

aspen

Combination of enteral and parenteral nutrition in the acute phase of critical illness: An updated systematic review and meta-analysis

2022, Twelve RCTs with 5543 patients. outcome of 30-day mortality : no significant effect of any combination of EN with PN on "mortality within 30 days" was observed (RR = 1.0) , on hospital LOS, on the duration of MV

Aileen Hill MD[1,2] | Daren K. Heyland MD[3] | Luis A. Ortiz Reyes MSc[3]
Elena Laaf MSc[1] | Sebastian Wendt MSc[1,2] | Gunnar Elke MD[4] |
Christian Stoppe MD[5]

[1] Department of Intensive Care Medicine, Medical Faculty RWTH Aachen, Aachen, Germany

[2] Department of Anesthesiology, Medical Faculty RWTH Aachen, Aachen, Germany

[3] Clinical Evaluation Research Unit, Department of Critical Care Medicine, Queen's University, Kingston Health Sciences Centre, Kingston, Ontario, Canada

[4] Department of Anesthesiology and Intensive Care Medicine, University Medical Center Schleswig-Holstein, Campus Kiel, Kiel, Germany

Abstract

Background: Uncertainty remains about the best route and timing of medical nutrition therapy in the acute phase of critical illness. Early combined enteral nutrition (EN) and parenteral nutrition (PN) may represent an attractive option to achieve recommended energy and protein goals in select patient groups. This meta-analysis aims to update and summarize the current evidence.

Methods: This systematic review and meta-analysis includes randomized controlled trials (RCTs) targeting the effect of EN alone vs a combination of EN with PN in the acute phase of critical illness in adult patients. Assessed outcomes include mortality, intensive care unit (ICU) and hospital length of stay (LOS), ventilation days, infectious

Nutrition Research Reviews (2020), 33, 312–320
doi:10.1017/S0954422420000165

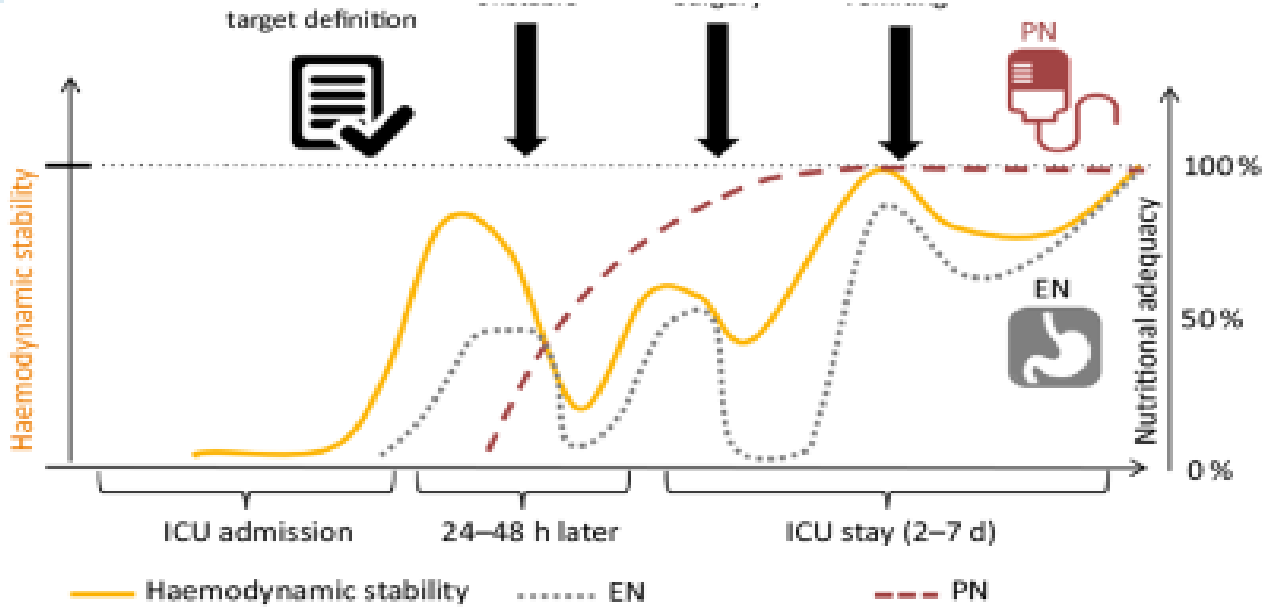
Meeting nutritional targets of critically ill patients by combined enteral and parenteral nutrition: review and rationale for the EFFORTcombo trial

Aileen Hill[1,2*], Daren K. Heyland[3], Gunnar Elke[4], Stefan J. Schaller[5], Reto Stocker[6], Christoph Haberthür[6], Christian von Loeffelholz[7], Ulrich Suchner[8], Zudin A. Puthucheary[9], Danielle E. Bear[10,11], Julia Ney[1,2], Kai C. Clasen[1,2], Patrick Meybohm[12], Simone Lindau[12], Thea Laurentius[13] and Christian Stoppe[1,2*]

1-PN, as well as EN+PN seem to be safe, feasible and effective to achieve the prescribed nutritional targets in critically ill patients.

2-metabolic tolerance

3-In nutritionally high-risk patients, combined EN+PN may improve functional and other patient reported outcomes



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Early versus Late Parenteral Nutrition in Critically Ill Adults

Michael P. Casaer, M.D., Dieter Mesotten, M.D., Ph.D., Greet Hermans, M.D., Ph.D., Pieter J. Wouters, R.N., M.Sc., Miet Schetz, M.D., Ph.D., Geert Meyfroidt, M.D., Ph.D., Sophie Van Cromphaut, M.D., Ph.D., Catherine Ingels, M.D., Philippe Meersseman, M.D., Jan Muller, M.D., Dirk Vlasselaers, M.D., Ph.D., Yves Debaveye, M.D., Ph.D., Lars Desmet, M.D., Jasperina Dubois, M.D., Aime Van Assche, M.D., Simon Vanderheyden, B.Sc., Alexander Wilmer, M.D., Ph.D., and Greet Van den Berghe, M.D., Ph.D.

ABSTRACT

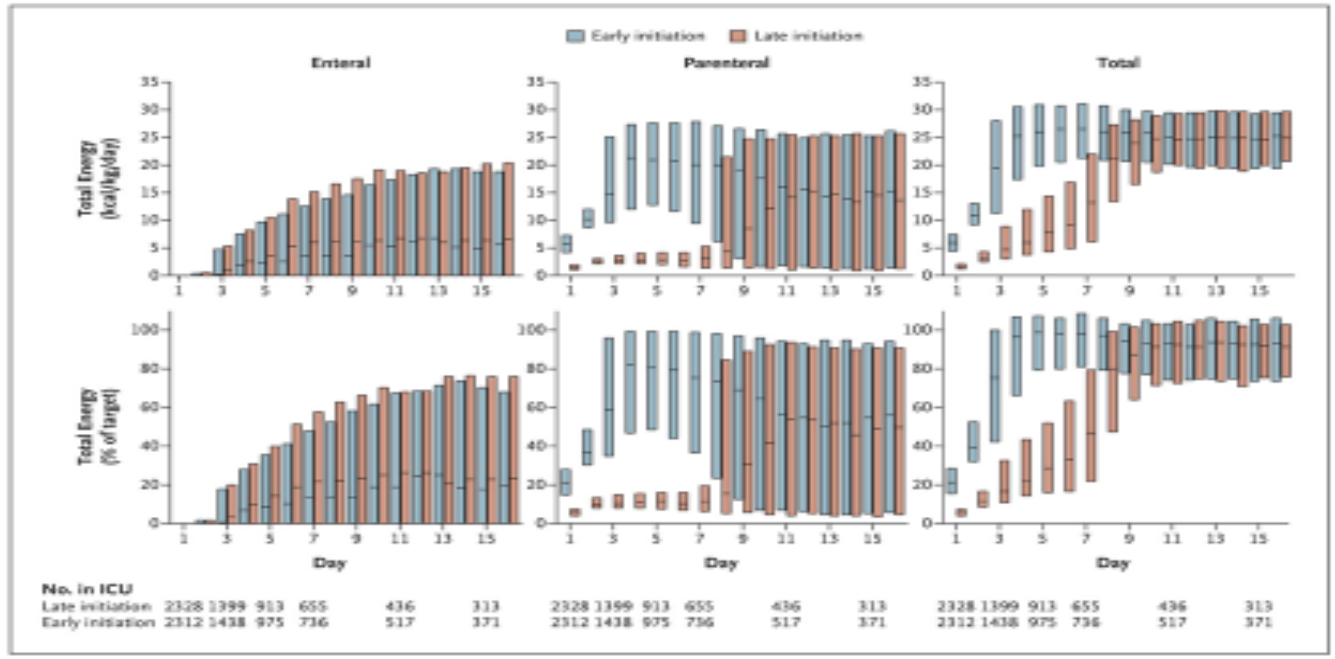
BACKGROUND

Controversy exists about the timing of the initiation of parenteral nutrition in critically ill adults in whom caloric targets cannot be met by enteral nutrition alone.

METHODS

From the Department of Intensive Care Medicine (M.P.C., D.M., P.J.W., M.S., G.M., S.V.C., C.I., J.M., D.V., Y.D., L.D., S.V., G.V.B.) and the Medical Intensive Care Unit, Department of Internal Medicine

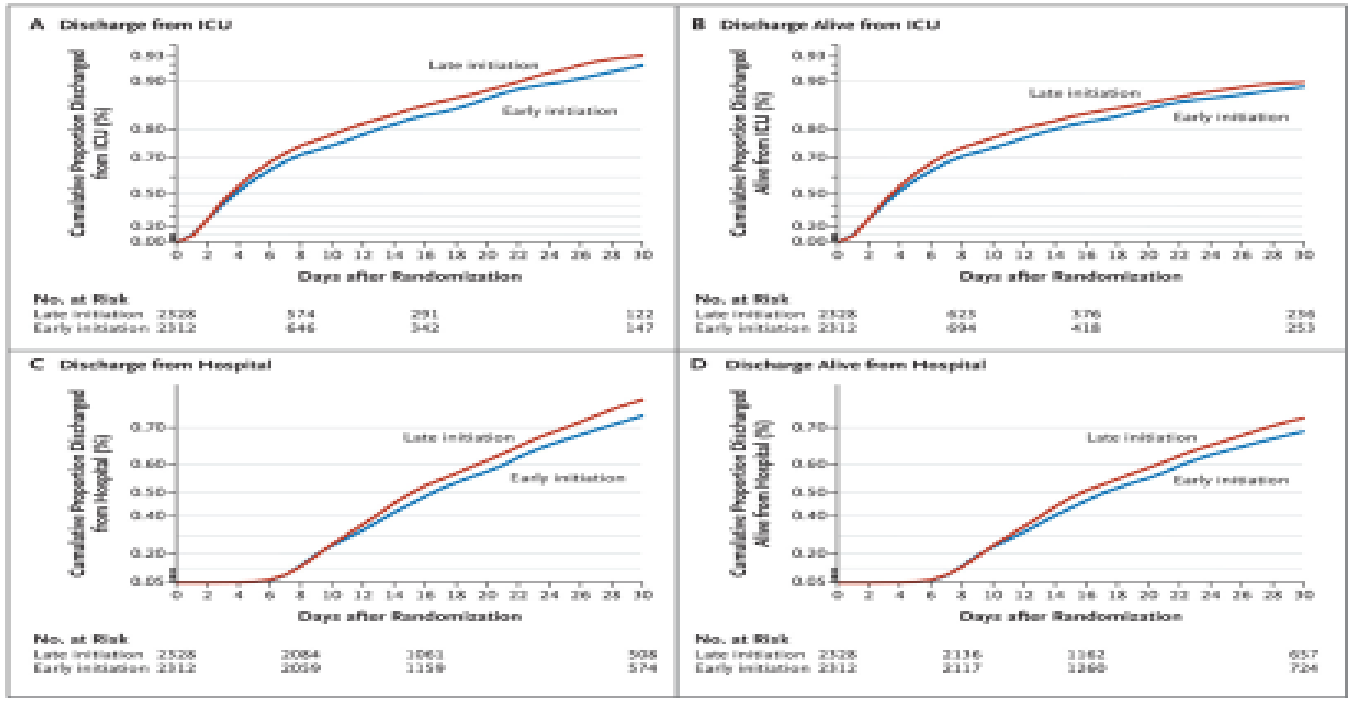
Early versus Late Parenteral Nutrition in Critically Ill Adults



In this randomized, multicenter trial, we compared early initiation of parenteral nutrition (European guidelines) with late initiation (American and Canadian guidelines) in adults in the intensive care unit (ICU) to supplement insufficient enteral nutrition. In 2312 patients, parenteral nutrition was initiated within 48 hours after ICU admission (early-initiation group), whereas in 2328 patients, parenteral nutrition was not initiated before day 8 (late-initiation group). A protocol for the early initiation of enteral nutrition was applied to both groups, and insulin was infused to achieve normoglycemia.

Michael P. N. Early versus Late Parenteral Nutrition in Critically Ill Adults. Engl J Med 2011

-Continued



Michael P. N. Early versus Late Parenteral Nutrition in Critically Ill Adults. Engl J Med 2011

Patients in the late-initiation group had a relative increase of 6.3% in the likelihood of being discharged **alive earlier from the ICU** (hazard ratio, 1.06; 95% confidence interval [CI], 1.00 to 1.13; P=0.04) and **from the hospital** (hazard ratio, 1.06; 95% CI, 1.00 to 1.13; P=0.04), without evidence of decreased functional status at hospital discharge. **Rates of death in the ICU and in the hospital and rates of survival at 90 days were similar in the two groups**. Patients in the late-initiation group, as compared with the early-initiation group, had **fewer ICU infections** (22.8% vs. 26.2%, P=0.008) and a lower incidence of cholestasis (P<0.001). The late-initiation group had a relative reduction of 9.7% in the proportion of patients requiring more than 2 days of **mechanical ventilation** (P=0.006), a median reduction of 3 days in the duration **of renal-replacement therapy** (P=0.008), and a mean reduction in health care costs of €1,110 (about $1,600) (P=0.04).

nutrients

MDPI

Article

Parenteral Nutrition: Current Use, Complications, and Nutrition Delivery in Critically Ill Patients

Juan Carlos Lopez-Delgado [1,2,*], Teodoro Grau-Carmona [3,4], Esther Mor-Marco [5], Maria Luisa Bordeje-Laguna [5], Esther Portugal-Rodriguez [6], Carol Lorencio-Cardenas [7], Paula Vera-Artazcoz [8], Laura Macaya-Redin [9], Beatriz Llorente-Ruiz [10], Rayden Iglesias-Rodriguez [11], Diana Monge-Donaire [12], Juan Francisco Martinez-Carmona [13], Laura Sanchez-Ales [14], Angel Sanchez-Miralles [15], Monica Crespo-Gomez [16], Cristina Leon-Cinto [17], Jose Luis Flordelis-Lasierra [3,4], Lluis Servia-Goixart [18,19] and on behalf of the ENPIC Study Group [†]

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2 IDIBELL (Biomedical Investigation Institute of Bellvitge), Av. de la Gran Via, 199, 08908 L'Hospitalet de Llobregat, Barcelona, Spain
3 Intensive Care Department, Hospital 12 de Octubre, Av. de Córdoba s/n, 28041 Madrid, Spain
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5 Intensive Care Department, Hospital Universitario Germans Trias i Pujol, Carretera de Canyet, s/n, 08916 Badalona, Barcelona, Spain

2023, 629 patients :
PN showed similar nutritional delivery when compared with the EN . use of PN as the initial route for nutrition therapy, even when initiated early, may be not associated with major complications in adult critical care patients and may help provide adequate nutrition delivery during the entire ICU admission. nutrition therapy in those patients who received initial PN and are expected to have longer ICU stays may potentially benefit from considering EN as complementary to PN or progressively switching from PN to EN, especially in terms of protein delivery

Circumstances in which PN is the preferred route for nutrition support?

- Do not use PN based solely on medical diagnosis or disease state.

- Prior to initiating PN, conduct a full evaluation of the feasibility of using EN; reserve PN for clinical situations in which adequate EN is not an option
- Use PN in patients who are malnourished or at risk for malnutrition when a contraindication to EN exists or the patient cannot tolerate adequate EN or lacks sufficient bowel function to maintain or restore nutrition status due to gastrointestinal dysfunction
- Nutrition support is indicated in patients who are malnourished or at risk for developing malnutrition. In these cases, EN support has been generally accepted as the first line of nutrition support. The use of EN support may offer physiologic and immunologic benefits to the gut. Prolonged disuse of the gut results in downregulation of many digestive enzymes that may become evident upon reinitiation of EN.
- Furthermore, PN, in the past, may have increased the risk of infection due to intravenous access, which prolonged hospital and ICU stays, but this type of infectious complication has become less prevalent as central venous access device care and blood glucose control have improved.

Nutritionally-At-Risk Adult

Involuntary weight loss of 10% of usual body weight within 6 months or 5% within 1 month

BMI less than 18.5 kg/m2

Increased metabolic requirements

Altered diets or diet schedules

Inadequate nutrition intake, including not receiving food or nutrition products for more than 7 days

Patricia Worthington . When Is Parenteral Nutrition appropriate? : 17 February 2017

Assessment:

Hx and exam, Disease status, Functional assessment, Lab tests, Fluid balance

Functional tests:
Hand dynamometry: hand grip
Direct muscle stim: electrical stim of the adductor pollicis muscle , Respiratory function:
close correlation between Expiratory and inspiratory force and total body protein, with rapid decline after 20% loss of body protein.

Immune function:

A lymphocyte count of 900-1500 cells/mm indicates moderate and <900 cells/mm severe malnutrition

Techniques used in nutritional assessment:

Anthropometry: Body weight, BMI, MAC, TSF, AMA

$$\text{for men AMA} = \frac{(\text{MAC} - \pi\text{TSF})^2 - 10}{4\pi}$$

$$\text{for women AMA} = \frac{(\text{MAC} - \pi\text{TSF})^2 - 6.5}{4\pi}$$

Arm Muscle Area

Lab parameters: Serum Alb(>18 days) , Cr, transthyretin (2 days) and transferrin (7 days) ,LFT, and electrolytes, Ca, Po4- and Mg, Zn, selenium, Fe, CRP

Bioelectrical impedance spectroscopy (BI) and DEXA: is highly variable with abnormalities of fluid balance. FFM and FM are estimated by BIA or DXA-scan. DXA is regarded as a more accurate method on an individual level. It is an accepted reference method to evaluate BIS. DXA gives information on FM, lean soft tissue (LST) and bone mineral content (BMC).

Karin Barendregt. Basic concepts in nutrition: Diagnosis of malnutrition- Screening and assessment. J of Clin Nut 2008

Actual Body Weight : the weight measured during hospitalization or reported just before the hospitalization

Adjusted body weight: is applicable in the obese patient : (actual body weight - ideal body weight) × 0.33 + ideal body weight

Dry weight : weight before fluid resuscitation) for patients with a BMI up to 30 kg/m2

Ideal body weight : men : 50 + (0.91 × [height in cm – 152.4]) and in women : 45.5 + (0.91 × [height in cm – 152.4]).

A. Clinical history

1. Change in weight
Weight loss in the past 6 months Total: #_____ kg, % lost#_____
Change in the past 2 weeks: _____ increase, _____ no change, _____ decrease

2. Changes in food intake (as compared to usual intake)
_____ no change
_____ change _____ duration = # _____ weeks
_____ type: _____ suboptimal solid diet _____ liquid diet
_____ low-calorie fluids _____ fasting

3. Gastrointestinal symptoms (> 2 weeks in duration)
_____ none, _____ nausea, _____ vomiting, _____ diarrhoea, _____ anorexia

4. Functional capacity
_____ no dysfunction
_____ dysfunction _____ duration = # _____ weeks
_____ type: _____ working suboptimal
_____ ambulatory
_____ bedridden

5. Disease and its relationship to energy requirements
Primary diagnosis (especify): _____
Metabolic demand (stress): _____ no stress, _____ low stress
_____ moderate stress, _____ high stress

B. Physical examination (specify for each: 0 = normal, 1 = mild, 2 = moderate, 3 = severe)

_____ loss of subcutaneous fat tissue (triceps, chest)
_____ loss of muscle mass (quadriceps, deltoid)
_____ ankle oedema
_____ sacral oedema
_____ ascites

C. Subjective Global Assessment (grading)

_____ A = well nourished
_____ B = moderate or suspected undernutrition
_____ C = severely undernourished

SGA

Rubric I. Anthropometric assessment (maximum 8 points)	
Body weight and height, and related calculation of BMI[a]	0–3 points
Arm circumference	0–1 points
Calf circumference	0–1 points
3-Month weight loss[a]	0–3 points
Rubric II. General status assessment (maximum 9 points)	
Independence of living	0–1 points
Recent acute events (disease or psychological distress)[a]	0–2 points
Presence of pressure or skin ulcers	0–1 points
Number of medications taken on	
Cognition/depression[a]	
Mobility[a]	0–2 points
Rubric III. Dietary assessment (maximum 9 points)	
Eating problems (appetite, swallowing, chewing)[a]	0–2 points
Number of full meals	0–2 points
Markers of protein intake	0–1 points
Intake of vegetables and fruit	0–1 points
Intake of liquids	0–1 points
Self-sufficiency in eating	0–2 points
Rubric IV. Self-perceived health and nutrition states (maximum 4 points)	
Self-perception of nutritional status	0–2 points
Self-perception of health status	0–2 points

MNA

Nutrition Assessment Tools

Subjective Global Assessment (SGA)

Mini Nutritional Assessment (MNA)

comorbid conditions, function of the GI tract, and risk of aspiration.

Don't use of traditional nutrition indicators or surrogate markers, as they are not validated in critical care.

US : measure muscle mass and determine changes in muscle tissue at bedside in the ICU.

CT scan :precise quantification of skeletal muscle and adipose tissue depots.it is costly. Assessment of muscle function is still in its infancy. may be of value in the future.

SGA has a better predictive value than the MNA even in an elderly population. The SGA was developed to both assess the nutrition status and predict the clinical outcomes of surgical patients whereas the MNA was developed solely to assess the nutrition status of elderly patients

Markers used in AKI and their limitations

Markers	*Limitations*
Prealbumin, albumin, and cholesterol	May be decreased irrespective of PEW
Leukocyte count	Less specificity
Modifications in body weight	Total body water is elevated in AKI Hypervolemia and edema can mask the changes in muscle mass
Anthropometry (skinfold, triceps, arm circumference, etc.)	Affected by edema
Protein catabolic rate or protein equivalent of nitrogen emergence	Measurements require calculations based on urea kinetics during RRT + collection of dialysates
Energy expenditure	Prediction formulas are not constantly accurate in critically ill patients (they are generally based on body weight)
Nutritional score (SGA and its changes)	Most of the data are from CKD patients and not specifically validated in critically ill patients

ISRNM recommends that serum albumin less than 3.8 g/dL can be used as a diagnostic parameter of PEW in AKI as well as CKD.

The serum stability, short half-life, and good correlation with nutritional status make IGF-1 an early and sensitive indicator of mortality in AKI patients.

ISRNM now recommends cholesterol levels be included for biochemical assessment of PEW in AKI.

in patients with AKI and CKD, the reverse is noted, with increased BMI being associated with better outcome including survival

Nutrition Support in Critically Ill Patients with AKI

Loss of kidney function affects the metabolism of all macronutrients in this hypermetabolic state(insulin resistance, acute phase reaction, and increased circulation of catabolic hormones) where hypertg and hyperglc are common.Malnutrition in AKI may impact outcome including hospital LOS and mortality.

PN in patients with renal failure aims at reduction of the hypercatabolic state, and the prevention or elimination of malnutrition and related functions, such as immunology, wound healing, antioxidative potential, inflammation. While delaying the progress of CRF through protein or phosphate restriction is the aim of chronic dietary therapy, this is not the goal of short-term PN, which is usually administered only in acute situations

- To reduce negative protein balance and prevent protein-energy malnutrition
- To retain lean body mass and maintain normal body composition
- To avoid metabolic derangements and improve biochemical parameters
- To improve respiratory function capacity and healing
- To improve kidney function
- To improve overall outcomes and reduce mortality

Indian Journal of Critical Care Medicine, April 2020;24 (Suppl 3)

Protein Catabolism

Alterations of the metabolism of individual AA, including the utilization of exogenously administered AA is altered, **and various non-essential amino acids, e.g. tyrosine, may become indispensable.**

Altered lipid metabolism

hypertriglyceridemia explained by the **suppressed lipolysis**. Fat clearance is delayed after enteral or parenteral intake

Dysfunctions in carbohydrate metabolism

Hyperglycemia: **peripheral insulin resistance**, and in addition by an activation of hepatic **gluconeogenesis** that cannot be suppressed by exogenous nutrient intake, other than in stable CRF and healthy persons ("obligatory" negative nitrogen balance).

Metabolic disorders in patients with RF

Peripheral insulin resistance

Impairment of lipolysis

Metabolic acidosis

Hyperparathyroidism

Dysfunction in vitamin D_3 activation

Lower potassium tolerance/hyperkalaemia

Chronic inflammatory reaction

Activation of protein catabolism

Exuberant catabolism in intercurrent acute diseases

. Nephrol Dial Transplant. 2005;20(9):1976- 80. Fiaccadori

Energy metabolism is not markedly influenced by renal dysfunction but may be altered by underlying disease and accompanying complications. In MOF, energy expenditure is only about 30% above the calculated resting metabolic rate.

An increase in energy intake of more than **30 kcal/kg/day** was not associated with any further improvement in nitrogen balance, but resulted in increased metabolic complications

If fat-free TPN is used, essential fatty acid deficiency may appear after about 3 weeks.

The amount of protein is adjusted **depending on the underlying condition. patients in critical conditions require 1.5 g/kg/day of protein, 0.6 to 0.8 g/kg/day with CKD, 1.2 to 1.3 g/kg/day with hemodialysis**, and a temporary protein restriction with acute hepatic encephalopathy

Nutritional Requirements

Degrees of stress and complex metabolic abnormalities

measurement of excretion of urine urea nitrogen and variation in body urea nitrogen. In patients requiring dialysis, dialysate losses should be included in the total nitrogen loss.

Patients with lower catabolism:

- loss of nitrogen up to 5 g of ingested dietary nitrogen , nephrotoxicity
- low mortality rates (~ 20%), rarely require dialysis

Patients with moderate catabolism:

- nitrogen loss of 5–10 g/day surgeries and infections
- higher mortality rates (~ 60%)
- may require dialysis

Patients with marked catabolism:

nitrogen loss of >10 g/day, sepsis or severe injuries , high mortality rates (80%)

- frequently require dialysis.

survival rate increased to 20%, with increase in nitrogen balance by 1 g/day, which can be achieved with appropriate nutritional support.

$$NB = \frac{\text{protein intake}}{6.25} - \left[\frac{UUN}{0.8} + 2.5g\right]$$

NB = Nitrogen Balance (g/d)
Protein intake (g/d)
UUN = Urea Nitrogen (U, g/d)
*UUN/0.8 represents UUN + urinary non-urea N+.
*2.5 is the sum of fecal + integumental nitrogen.

هدف از تعادل نیتروژن ، حفظ بالانس مثبت 4-6 گرم می باشد

Energy Expenditure

Harris Benedict formula[17]:

Males. Energy expenditure = 66 + (13.7 x weight) + (5 x height) - (6.8 x age)
Females. Energy expenditure = 655.1 + (9.6 x weight) + (1.8 x height) - (4.7 x age)

IC: availability and cost. (25–30 kcal/kg/d)
Variables : chest tubes, O2 (nasal cannula, bilevel positive airway pressure), ventilator settings (FIO2, PEEP), CRRT, anesthesia,

Special formulas[18]:

De Luis.
Males: Energy expenditure = 58.6 + (6.2 x weight) + (1,023 x height) - (9.5 x age)
Females: Energy expenditure = 1,272.5 + (9.8 x weight) - (61.6 x height) - (8.2 x age)

Schofield.
Males
18-30 years: Energy expenditure = 15.3 x weight + 679
30-60 years: Energy expenditure = 11.6 x weight + 879
> 60 years: Energy expenditure = 13.5 x weight + 487

Females
18-30 years: Energy expenditure = 14.7 x weight + 496
30-60 years: Energy expenditure = 8.7 x weight + 829
> 60 years: Energy expenditure = 10.5 x weight + 596

-Composition

Mild stress ; 20-25 Kcal/kg

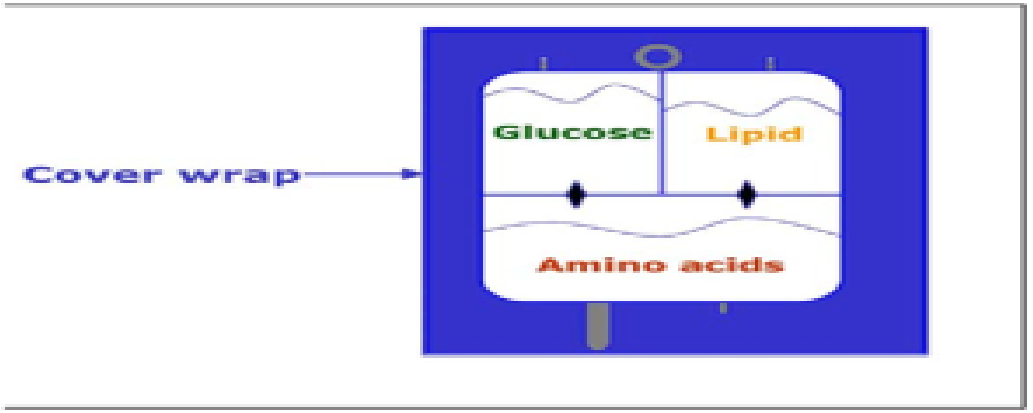
Moderate stress:25-30 Kcal/kg

Severe stress: 30-35 Kcal/kg

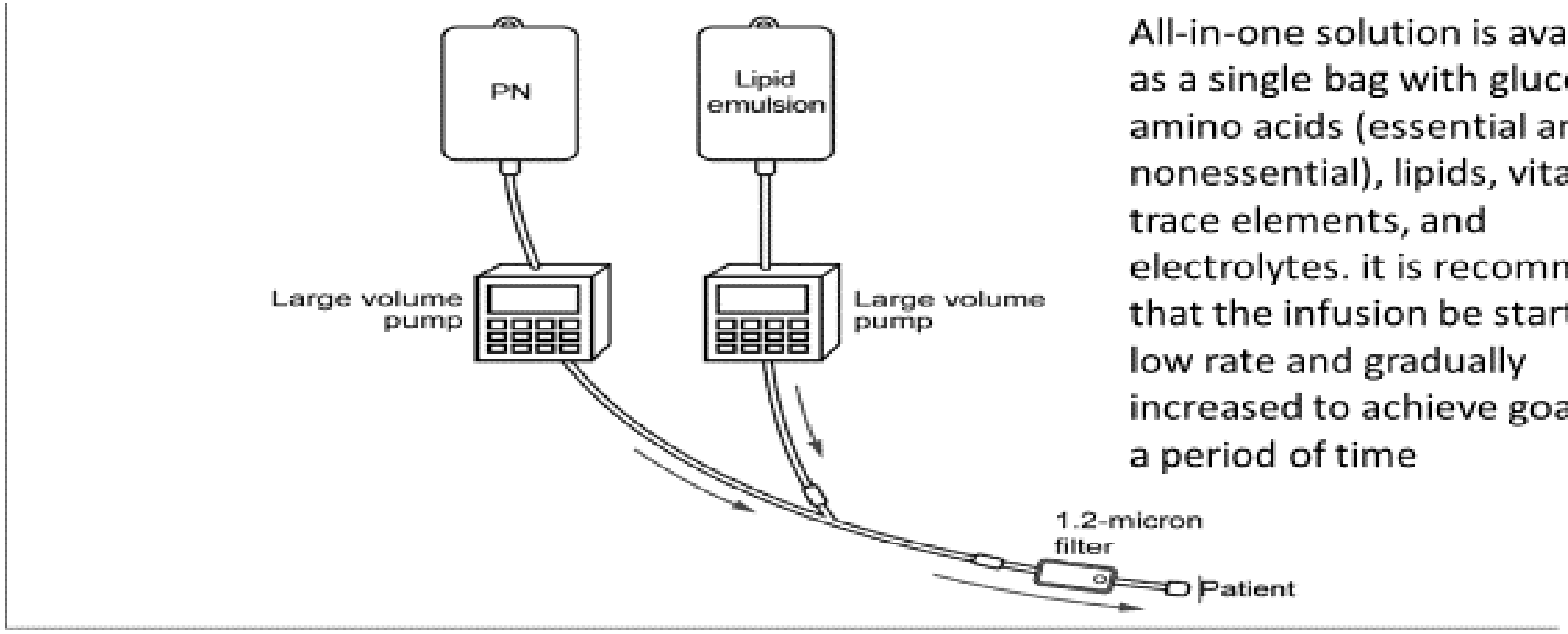
Rarely in Burning : 40Kcal/kg

Carbohydrates: Dextrose 70%
Lipid : Interalipid 10-20%
Protein : Amino Acids 10%
Vitamins : Multivitamin
Minerals , Electrolytes and Trace Elements

No significant difference in clinical outcomes was found between patients with higher vs lower levels of energy intake.12 and 25 kcal/kg



Setup for use of a 1.2-micron administration of dextrose-amino admixture with lipid injectable emulsion



All-in-one solution is available as a single bag with glucose, amino acids (essential and nonessential), lipids, vitamins, trace elements, and electrolytes. it is recommended that the infusion be started at a low rate and gradually increased to achieve goals over a period of time

Energy and Lipid

- Weight : 60 kg moderate stress: 30 kcal/kg ventilated
- Kcals: 1800 kcal
- Lipid :1800 kcal x 25% = 450 kcal from lipid
- 1gr fat =9 kcal
- 450/9 = 50 gr interalipid 10% 500 cc
- mixed-oil ILEs (medium-chain triglycerides, olive oil, FO, mixtures of oils) or 100% SO ILE (2016 guideline)
- within the first week of ICU admission

Dextrose and protein

Dextrose:

1800-450= 1350 kcal

1gr dextrose :3/4 kcal energy

1350/3/4 = 400 gr

1 liter D/S = N/S+ 50gr Dext

1 Liter D/w 20% +1 liter D/W 10%

2 vial Glu 50% (1 vial Glu 50% : 25gr glucose)

dextrose monohydrate—most frequently as 40%, 50%, and 70% concentration—ranges from 5 to 7 mg/kg/min

Nitrogen x 6/25=protein

Protein: 1.6 – 2.2 gr /kg

60 x 1.6= 100gr protein

Aminofiosion 10% = 1 liter

Aminofiosion always administrate with dextrose

1.2–2.0 g/kg/day (2016 guideline)

Disease	Deficiency favouring disease development	Inadequacy or deficit worsening the condition	Deficiency as a result of disease	References
Alcoholism		B1, Fe	A, D, E, K, B1, B2, B6, B7, B9, B12, C, Zn	[4, 44]
Alcoholic hepatitis	B6, Zn	Se, Zn		[45]
Anaemia	B1, B6, B9, B12, Fe, Cu, Co			[4]
Cancer cachexia	D, Zn			[46, 47]
Cardiomyopathies/ Heart failure	B1, B6, D, Se, Fe	Se		[4, 48, 49]
Chronic obstructive pulmonary disease	D, Cu, Se, Mn, Zn			[50, 51]
Chronic intestinal failure			B2, B7, B9, B12, A, D, E, K, Cu, Fe, Zn	[52–54]
Chronic (atrophic) gastritis			B9, B12, C, D, Fe	[55, 56]
Diabetes mellitus	B9, Cr			[57-61]
Inflammatory bowel diseases		Zn	B1, B6, B12, A, D, E, K, Fe, Se, Zn	[4, 62]
Non-alcoholic fatty liver disease	Cu			[63]
Liver diseases		Zn	B12, A, D, E, Se, Zn	[4, 64, 65]
Multiple Sclerosis	B7			[66]
Obesity	β-carotene, E, Se, Zn	B1, B9, D, Fe, Se, Zn		[55,67–69]
Obesity Post Bariatric surgery			A, D, E, K, B1, B9, B12, C, Cu, Fe, Zn	[69–71]
Osteoporosis	B12, D, K, Cu, Fe, Zn, Mn, F, Bo			[72, 73]
Renal failure (chronic)			Carnitine, Fe B1, B6, B9, K, D, Cu, Se, Zn	[74, 75]
Sarcopenia	B1, B12, D, carnitine, Zn	D, Se, Zn		[55, 76]
Critical illness		B1, C, D, Cu, Fe, Se, Zn	B1, B12, C, D, Fe, Se, Zn	[76–79]

ESPEN micronutrient guideline 2022

Carnitine is not classified as a vitamin but being essential in energy metabolism it has been included as "assimilated vitamin" in the present guidelines

- The multi-chamber bags developed by Technoflex are made of a polypropylene-based film with a high oxygen barrier. This particular property protects amino acids against oxidation, the main factor in their degradation.

- The bags are compartmentalized into two or three chambers containing macronutrients in the form of binary mixtures (glucose and amino acids) or ternary mixtures (lipids, amino acids and glucose). These standard mixtures are suitable for the majority of patients. To prevent the inevitable interactions between some of these macronutrients, peelable welds (removable thermo-welds) are put in place to separate them from each other. In order to reconstitute the mixture, the welds are simply squeezed by hand to break them.

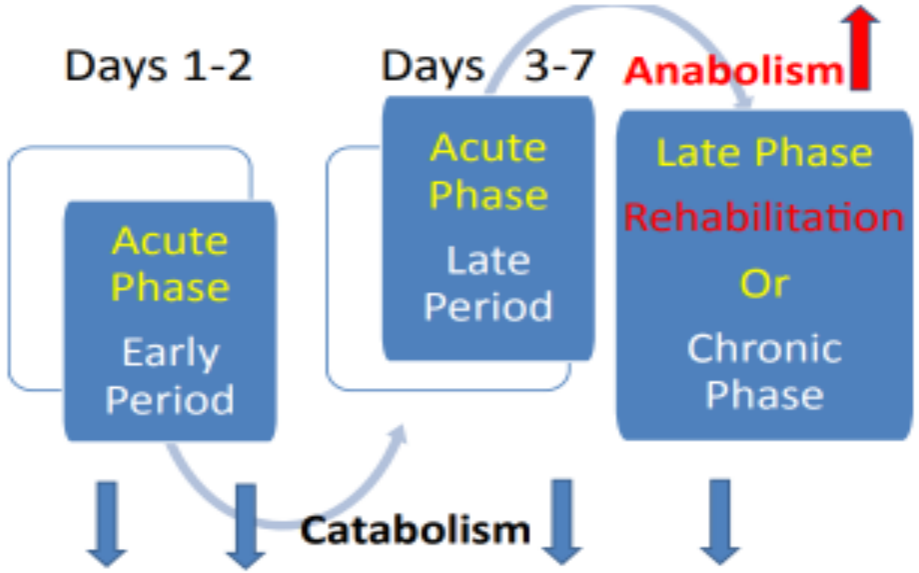
- Multi-chamber bags for parenteral nutrition offer many advantages. They enhance patient safety as they reduce handling and thus the risks of contamination of the nutritional mixture.

- Initiate PN after 7 days for well-nourished, stable patients who have been unable to receive significant (50% or more of estimated requirements) oral or enteral nutrients.
- Initiate PN within 3–5 days in those who are nutritionally-at-risk and unlikely to achieve desired oral intake or EN.
- Initiate PN as soon as is feasible for patients with baseline moderate or severe malnutrition in whom oral intake or EN is not possible or sufficient.
- hypocaloric PN dosing (≤20 kcal/kg/d or 80% of estimated energy needs) with adequate protein (≥1.2 g protein/kg/d) be considered in high risk or severely malnourished patients requiring PN, initially over the first week of hospitalization in the ICU.
- Delay the initiation of PN in a patient with severe metabolic instability until the patient's condition has improved.
- withholding or limiting SO-based IVFE during the first week in the critically ill patient to a maximum of 100 g/wk (often divided into 2 doses/wk) if there is concern for essential fatty acid deficiency.
- as tolerance to EN improves, the amount of PN energy should be reduced and DC when the patient is receiving >60% of target energy requirements from EN.

Time frame

Patricia Worthington . When Is Parenteral Nutrition appropriate? : 17 February 2017

Medical nutrition therapy shall be considered for all patients staying in the ICU, mainly for more than 48 h



Clinical Conditions Warranting Cautious Initiation of Parenteral Nutrition in Adults

Hyperglycemia	Glucose greater than 180 mg/dL
Azotemia	Blood urea nitrogen greater than 100 mg/dL
Hypertriglyceridemia	Serum triglycerides greater than 200 mg/dL
Hyponatremia	Serum sodium less than 130 mEq/L
Hypernatremia	Serum sodium greater than 150 mEq/L
Hypokalemia	Serum potassium less than 3 mEq/L
Hypomagnesemia	Serum magnesium less than 1.3 mEq/L
Hypocalcemia	Ionized calcium less than 4.5 mg/dL
Hypophosphatemia	Serum phosphorus less than 2 mg/dL

Parameter	Baseline	Days 1–7	Ongoing, Stable	Initial, Postdischarge	Weeks 1–4 (or Until Stable)	At 3 mo	Ongoing, Stable
Glucose, BUN, creatinine, electrolytes, calcium, magnesium, phosphorus	✓	Daily × 3 or until stable	1–2×/wk or as clinically indicated	✓	✓		Monthly
CBC with differential	✓	Daily × 3 or until stable	1–2×/wk	✓	✓		Monthly
Total bilirubin, direct bilirubin, AP, AST, ALT,	✓		Weekly	✓			Monthly
PTT, PT, INR	✓		Weekly				Monthly
Triglyceride level	✓	Pediatric: daily until stable then weekly	Weekly	✓			Monthly
Serum proteins (to monitor inflammation)	✓		Weekly	✓			Monthly
Iron indices			As clinically indicated			✓	Every 3–6 mo
Zinc, selenium, manganese, copper, chromium			As clinically indicated			✓	Every 3–6 mo
Vitamin A, 25-OH vitamin D, vitamin E			As clinically indicated			✓	Every 12 mo
Vitamin B_{12} and folate			As clinically indicated			✓	Every 6–12 mo
TSH				As indicated			Every 12 mo
Carnitine			No guideline for adults			✓ Pediatric patients	Every 3–12 mo

The standard monitoring recommendations ASPEN and ESPEN

CBC ,FBS , TG , electrolytes, total and direct bilirubin, GGT, AST, ALT ALP, total albumin and protein, and kidney function tests (SCr and urea) up to 3 times daily after initiating TPN until stable.

Portz E, Kurashima K, Unes M, et al. The efects of total parenteral nutrition in patients with kidney disease. Turk J Nephrol. 2024;33(3):235-243.

ASPEN recommendations for patients with RF

PN osmolality of up to 900 mOsm/L

maintaining the final amino acid, monohydrated dextrose, and lipid emulsion concentrations at ≥4%, ≥10%, and ≥2%, respectively, in 3-in-1 admixtures for the stability of up to 9 days refrigerated (5°C) followed by 24 hours at room temperature

Wean PN when oral intake and/or EN achieves 50%–75% of requirements for energy, protein, and micronutrients, unless impaired gastrointestinal function precludes 100% absorption of nutrient needs.

Consider using a weaning protocol during the transition from PN to EN

Portz E, Kurashima K, Unes M, et al. The efects of total parenteral nutrition in patients with kidney disease. Turk J Nephrol.2024;33(3):235-243.

Kidney International, Vol. 65 (2004), pp. 998–1008

Enteral nutrition in patients with acute renal failure

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Enteral nutrition in patients with acute renal failure.

Background. Systematic studies on safety and efficacy of enteral nutrition in patients with acute renal failure (ARF) are lacking.

Methods. We studied enteral nutrition–related complications and adequacy of nutrient administration during 2525 days of artificial nutrition in 247 consecutive patients fed exclusively by the enteral route: 65 had normal renal function, 68 had ARF not requiring renal replacement therapy, and 114 required renal replacement therapy.

Results. No difference was found in gastrointestinal or mechanical complications between ARF patients and patients with normal renal function, except for high gastric residual volumes, which occurred in 3.1% of patients with normal renal function, 7.3% of patients with ARF not requiring renal replacement therapy, 13.2% of patients with ARF on renal replacement therapy ($P = 0.02$ for trend), and for nasogastric tube obstruction: 0.0%, 5.9%, 14%, respectively ($P < 0.001$). Gastrointestinal complications were the most frequent cause of suboptimal delivery; the ratio of administered to prescribed daily volume was well above 90% in all the three groups. Definitive withdrawal of enteral nutrition due to complications was documented in 6.1%, 13.2%, and 14.9% of patients, respectively ($P = 0.09$ for trend). At regimen, mean delivered nonprotein calories were 19.8 kcal/kg (SD 4.6), 22.6 kcal/kg (8.4), 23.4 kcal/kg (6.5); protein intake was 0.92 g/kg (0.21), 0.87 g/kg (0.25), and 0.92 g/kg (0.21), the latter value being below that currently recommended for ARF patients on renal replacement therapy. Median fluid intake with enteral nutrition was 1440 mL (range 720 to 1960), 1200 (720 to 2400), and 960 (360 to 1920).

Conclusion. Enteral nutrition is a safe and effective nutritional technique to deliver artificial nutrition in ARF patients. Parenteral aminoacid supplementation may be required, especially in patients with ARF needing renal replacement therapy.

of complications and death [1]. Nutritional support is thus considered a cornerstone of ARF treatment [2].

The major body of evidence supports use of the enteral instead of the parenteral route for nutrient administration in the critically ill [3, 4]. Although the same might be appropriate for patients with ARF [2], so far no systematic studies on enteral nutrition have been conducted in this category of patients [5]. In fact, published studies have dealt with patients with chronic renal failure on hemodialysis [6, 7] or pediatric patients [8, 9].

Enteral nutrition offers some potential advantages over parenteral nutrition in ARF. First, by using the more concentrated formulas, it allows restraint of fluid administration; second, it is less expensive than parenteral nutrition; and third, it may have a positive impact on survival [10]. On the other hand, theoretically at least, enteral nutrition may be implemented with difficulties, due to the gastrointestinal motility disorders of the uremic patients [11], a problem which may become especially prominent with the use of more concentrated enteral formulas. Moreover, with use of the enteral diet formulas currently available on the market, it may be difficult to achieve the protein intake usually recommended in catabolic conditions, such as ARF.

With the present study we aimed at assessing whether ARF carries an increased risk of complications and suboptimal delivery of nutrients when the enteral route is the only means of artificial nutrition.

To this end, we prospectively studied 247 consecutive patients (182 with ARF) with a period of enteral nutrition

2004:The first study that has systematically investigated both the safety and efficacy of AN administered solely via the EN in patients with ARF. GI complications were the most common reason for suboptimal delivery of nutrition.

parenteral AA supplementation is recommended in the case of ARF patients on RRT, in order to achieve currently recommended protein goals

combination of enteral and parenteral nutrition is sometimes needed to achieve the optimal nutritional support in this clinical setting

Nutrition Therapy in AKI

Only few systematic studies have performed on parenterally fed patients with renal failure, and only very few controlled studies with an acceptable study design have been published. Therefore, recommendations for practice for this patient group only reach the level of an expert opinion.

In malnourished and hypercatabolic patients, adequate nutrients should be provided to the patients on renal RRT.

In patients with a high-residual glomerular filtration rate, large amount of nutrients may be provided, as there is little risk of water and electrolyte disorders.

For patients recovering from AKI, the quantity of water, AA , and electrolytes should be appropriately limited to delay the need for dialysis until the renal function restores.

Fluid overload and hyponatremia should be avoided and sufficient calories and nitrogen should be given with minimal amount of water.

High biological value protein (all EAAs) may be given in adequate amounts in patients with AKI.

Nagarajan Ramakrishnan. Nutrition Support in Critically Ill Patients with AKI. Indian Journal of Critical Care Medicine, 2020

Final screening			
Impaired nutritional status		**Severity of disease** (≈ increase in requirements)	
Absent **Score 0**	Normal nutritional statusA	Absent **Score 0**	Normal nutritional requirements
Mild **Score 1**	Wt loss >5% in 3 months or Food intake below 50–75% of normal requirement in preceding week.	Mild **Score 1**	Hip fracture* Chronic patients, in particular with acute complications: cirrhosis*, COPD*. ***Chronic hemodialysis, diabetes, oncology.***
Moderate **Score 2**	Wt loss >5% in 2 months or BMI 18.5 – 20.5 + impairedgen. condition or Food intake 25–50%of normal requirement in preceding week	Moderate **Score 2**	Major abdominal surgery* Stroke* ***Severe pneumonia, hematologic malignancy***.
Severe **Score 3**	Wt loss >5% in 1 months (>15% in 3 months) or BMI <18.5 + impaired general condition or Food intake 0–25% of normal requirement in preceding week in preceding week.	Severe **Score 3**	Head injury* Bone marrow transplantation* ***Intensive care patients (APACHE>10).***
Score: +		**Score:**	**= Total score:**
Age	if ≥ 70 years: add 1 to total score above		**= age-adjusted total score:**
Score ≥3: the patient is nutritionally at-risk and a nutritional care plan is initiated			

Metabolic changes due to hemodialysis

Loss of water-soluble molecules with low molecular weight

- Amino acids
- Water-soluble vitamins
- L-carnitine etc.

Activation of protein catabolism through

- Loss of substrates (amino acids)
- Release of cytokines (TNF-α etc.)
- Blood loss

Special AA solutions (nephro-solutions) show beneficial effects on some surrogate parameters, but effects on clinical end points are not documented
Solutions providing exclusively essential AAs should no longer be used

Decrease in "uraemic intoxication"

plus

- Loss of heat (loss of energy)
- Loss of substrates (e.g. amino acids, vitamins) — 0.2 g per liter of filtrate
- Intake of substrates (lactate, citrate, glucose)
- Elimination of short-chained peptides (cytokines, hormones)
- Activation of mediator-cascades (alexin etc.)
- Stimulation of protein catabolism
- Electrolyte disorders (sodium, potassium, magnesium, phosphate)
- Induction of metabolic alkalosis

Loss of amino acids in various dialysis techniques

S. no	Type of dialysis	Protein/amino acid loss
1	Hemodialysis with low flux, cuprophane membrane	• Loss of 10–13 g amino acid per dialysis
2	Hemodialysis with high-flux dialyzers	• 8 g of free amino acid per session
3	Continuous RRT	• Protein loss of 1.3 g/L of output. • For 50 L of output per day the loss is up to 65 g/day
4	Peritoneal dialysis	• Average loss of 9.6 g protein per 24 hours in peritoneal fluid
5	Peritoneal dialysis with peritonitis	• Average loss of 15.1 g protein per 24 hours in peritoneal fluid

Disease-specific formulas used for patients with CKD on dialysis may also be given for AKI patients as they are high in calories (2 kcal/mL), high in protein (70 g/L), and low in electrolytes. There are also renal formulas with low protein that are calorie dense (2 kcal/mL) and used for pre dialysis patients with CKD

PN should be given for patients with significant gut dysfunction or those who are intolerant to enteral feedings. The combination of EN and PN when required to achieve nutritional goals has been shown to be safe, but it is highly recommended to make every attempt to feed enterally before pursuing options to include PN.

PN is customized and prepared under sterile conditions in hospitals in countries such as USA, while the standard premixed parenteral formulas are available in Europe and Asia.

Core Curriculum in Nephrology AJKD

Nutrition in Kidney Disease: Core Curriculum 2022

Helen L. MacLaughlin, Allon N. Friedman, and T. Alp Ikizler

As chronic kidney disease (CKD) progresses, the requirements and utilization of different nutrients change substantially. These changes are accompanied by multiple nutritional and metabolic abnormalities that are observed in the continuum of kidney disease. To provide optimal care to patients with CKD, it is essential to have an understanding of the applicable nutritional principles; methods to assess nutritional status, establish patient-specific dietary needs, and prevent or treat potential or ongoing nutritional deficiencies and derangements. This installment of AJKD's Core Curriculum in Nephrology provides current information on these issues for the practicing clinician and allied health care workers and features basic, practical information on epidemiology, assessment, etiology, and prevention and management of nutritional considerations in patients with kidney disease. Specific emphasis is made on dietary intake and recommendations for dietary patterns, and macro- and micronutrients. In addition, special conditions such as acute kidney injury and approaches to obesity treatment are reviewed.

Complete author and article information provided at end of article.

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General Indications for Supplemental Feeding, Enteral and Parenteral Nutrition with Chronic Kidney Disease

Oral Supplementation

If any one of the following indications are present:

- Eating < 75% of usual meals for > 7 days with acute illness
- Weight loss of 5% in 1 month with acute illness
- Mild to moderate loss of subcutaneous fat stores or muscle mass
- Eating < 75% of usual meals for at least 1 month with coexisting chronic illness
- Weight loss of 7.5% in 1 month with coexisting chronic illness
- Compromised swallow requiring modified texture diet ± thickened fluids

Enteral Tube Feeding

- When unsafe to swallow
- When adequate nutrition cannot be consumed orally

Parenteral Nutrition

- When digestive tract is inaccessible or nonfunctioning
- Intradialytic supplemental parenteral nutrition may be used during hemodialysis when specific criteria are met if oral nutrition supplementation has been unsuccessful

Intradialytic parenteral nutrition (IDPN)

It is PN supplied during HD To meet all energy, protein, and other nutrient requirements and can therefore be given only as often as dialysis.

Can assist to meet nutritional requirements if patients are achieving 20 kcal/kg per day but are unable to meet their full energy requirements. Nephrologists typically order the IDPN. IDPN alone is not sufficient, but it provides a considerable amount of energy and protein with each dialysis session to supplement the patient's oral or enteral intake

Financial barriers (cost of IDPN is ~$300 per day compared with a few dollars for oral supplements). Many insurers cover IDPN.

complications :electrolyte and lipid disorders

Its role in patients with AKI remains unclear.

Helen L. Nutrition in Kidney Disease: Core Curriculum .2022Am J Kidney Dis.

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Randomized control trials

Intradialytic parenteral nutrition in maintenance hemodialysis patients suffering from protein-energy wasting. Results of a multicenter, open, prospective, randomized trial☆

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2017, 107patients, first time
prealbumin, can be effectively improved

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SUMMARY

Background & aims: Protein-energy wasting (PEW) is increasingly becoming a clinical problem in maintenance hemodialysis patients and guidelines call for nutritional interventions. Serum prealbumin (transthyretin) represents a critical nutritional marker positively correlated with patient survival and negatively correlated with morbidity. Nutritional counseling, oral supplementation as well as intradialytic parenteral nutrition (IDPN) are recommended to fight PEW, however clinical trials on their use are scarce.

Methods: We conducted a prospective, multicenter, randomized, open-label, controlled, parallel-group Phase IV clinical trial in 107 maintenance hemodialysis patients suffering from PEW to assess the impact of IDPN on prealbumin and other biochemical and clinical parameters reflecting nutritional status. Patients randomized to the intervention group received standardized nutritional counseling plus IDPN three times weekly over 16 weeks followed by a treatment-free period of 12 weeks. The control group received standardized nutritional counseling only. Main trial inclusion criteria included moderate to severe malnutrition (SGA score B or C), maintenance hemodialysis therapy (3 times per week) for more than six months, and presence of two out of the following three criteria: albumin <35 g/L, prealbumin <250 mg/L, phase angle alpha <4.5° assessed by bioelectrical impedance analysis (BIA). Changes in serum prealbumin, albumin, transferrin, phase angle alpha, subjective global assessment (SGA) score and health-related quality of life using the 12-item short form health survey (SF-12) were

OPEN

The beneficial effects of intradialytic parenteral nutrition in hemodialysis patients with protein energy wasting: a prospective randomized controlled trial

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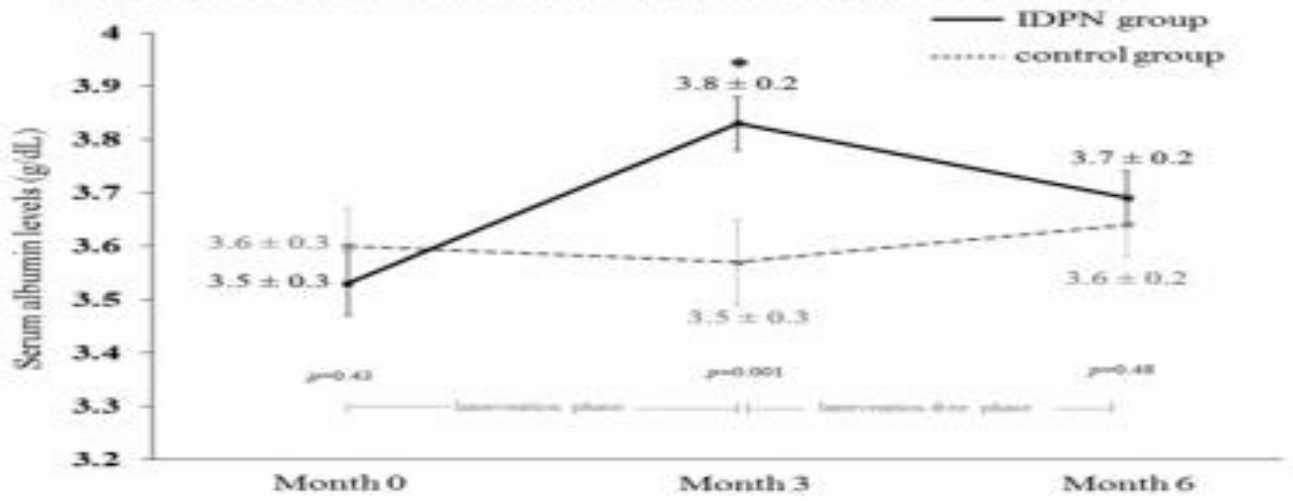
In hemodialysis (HD) patients, protein-energy wasting (PEW) is highly prevalent and firstly treated with oral nutritional supplements (ONS). The extent to which intradialytic parenteral nutrition (IDPN) contributes to improve PEW status in HD patients intolerable to ONS remains unclear. Maintenance PEW HD patients being unable to tolerate ONS adverse effects, and having spontaneous energy and protein intake of ≤ 20 kcal/kg/day and ≤ 0.8 g/kg/day, respectively were randomly assigned 1:1 into IDPN and control groups. In IDPN group, most concentrated 3-in-1, fish-oil based parenteral nutrition was infused during HD for 3 months. The control group received intensive dietary counselling once weekly for 3 months. Both groups were then followed for additional 3 months after intervention. A total of 38 patients were randomized (mean age 67.6 years). After 3 months, serum albumin was significantly higher in the IDPN (n = 18) compared with control group (from 3.5 ± 0.3 to 3.8 ± 0.2 vs from 3.6 ± 0.3 to 3.5 ± 0.3 g/dL, respectively, p = 0.01). Spontaneous dietary intake (p = 0.05), body weight (p = 0.01), and malnutrition inflammation score (MIS, p = 0.01) were improved in the IDPN, but not in the control group. Muscle mass, strength, serum prealbumin, interleukin-6, high sensitivity c-



open-label randomized controlled study: 3 months. Participants in the IDPN group received the most concentrated 3-in-1 parenteral nutrition formula consisting of glucose, essential and non-essential amino acids and fsh oil-based lipid emulsion with omega-3 fatty acids
IDPN was infused at a constant rate during 4 h, but not exceeding 250 ml/hour, via a venous drip chamber of HD machine using infusion pump. 3000 kcal/week. primary outcome : the change in serum albumin level

TPN-KD

A significant complication in patients receiving long-term TPN with the incidence ranging from 14% to 43% and can manifest in several ways, including acute and chronic kidney disease and electrolyte imbalances.

- Whenever possible, enteral nutrition should be used as the primary form of nutrition therapy for patients with kidney failure.
- The prevention and management of TPN-KD involves careful

monitoring of electrolyte imbalances and adjusting the composition of the TPN solution accordingly

Portz E, Kurashima K, Unes M, et al. The efects of total parenteral nutrition in patients with kidney disease. Turk J Nephrol.2024;33(3):235-243.

MECHANISMS OF TOTAL PARENTERAL NUTRITION-INDUCED KIDNEY DAMAGE

is not fully understood

Hyperglycemia is the most common adverse effect of TPN as well as the most common cause of kidney disease

(peripheral insulin resistance and reduce glucose utilization by peripheral tissues. an increase in stress hormones such as cortisol during trauma, illness, or surgery may induce gluconeogenesis)

TPN comprises large fuid volume and osmotic loads (from dextrose and amino acids), which acts as an osmotic diuretic leading to hyponatremia with high urine fow rate, osmolar clearance, urinary nonelectrolyte, nonurea solute excretion, and a net negative free water clearance

high protein load of TPN can induce metabolic acidosis, further contributing to hypertonic dehydration. metabolism of cationic amino acids and sulfur-containing amino acids (exogenous addition), the titratable acidity (TTA) of the infused parenetral solution, the addition of acidificant agents (hydrochloric acid, acetic acid), thiamine deficiency, disruption of carbohydrate and lipid metabolic pathways and D-fructose administration. Moreover, hypophosphatemia that appears during TPN therapy contributes significally to the maintenance of MA

TPN-induced osmotic diuresis may also contribute to electrolyte imbalance in the forms of hypokalemia, hypomagnesemia, and hypophosphatemia

COMPLICATIONS

Metabolic complications:

Electrolyte disturbances, and

Hyperglycemia & Hypertg

Liver dysfunction

Met Bone Dis , RS

Infectious complications

Mechanical complications

At the beginning of the use of PN, the administration of high doses of glucose frequently caused hyperglycemia. Infusion of short-acting insulin or by the addition of short-acting insulin into the bag (1-2 U/10 g of dextrose)

When TG levels become greater than 400 mg/dL, we recommend to reduce the fat provision (e.g., reducing the opening of the lipid compartment of the bag). Specifically, we suggest frequency of lipid administration of 1 to 4 times per week in proportion to the TG levels, although evidence based data are lacking

patients receiving olive oil and fish oil had a shorter time to termination of mechanical ventilation alive and a shorter time to ICU discharge alive

High doses of protein intake: high levels BUN and Cr, metabolic acidosis, and hypertonic dehydrartion

thiamine supplements (100-300 mg/d) during the first 3 d in patients with possible thiamine deficiency (severe malnutrition, anorexia nervosa or alcohol abuse) to prevent neurological side effects associated with glucose delivery during PN.

Refeeding Syndrome (RS)

severe and life-threatening electrolyte abnormalities (hypophosphatemia, hypokalemia, and hypomagnesemia), as well as sodium and fluid retention

potentially leading to respiratory failure, heart failure, and death. RS can be prevented through a stepwise and patient's tailored feeding protocol.

If indirect calorimetry is unavailable, a feeding protocol may significantly reduce the risk of overfeeding. In fact, as suggested since

many years in ICU where the patient is often metabolic instable, a protocol for management of PN may markedly decrease the incidence of PN-related complications

The ASPEN consensus recommendations for RS

Low BMI < 18.5 kg/m2

- Recent weight loss of 5% in 1 month or 7.5–10% in 3 to 6 months;
- None or negligible oral intake 5–6 days;
- Caloric intake < 75% estimated for >5 days during acute illness or injury;
- Caloric intake < 75% estimated energy for >1 month;
- Abnormal potassium, phosphorus, or magnesium serum concentrations;
- Loss of subcutaneous fat , Loss of muscle mass
- comorbidities (alcoholism, eating disorders, cancer, malabsorptive States)

Conclusion

- international observational studies revealed considerable practice variations,
- The existing clinical trial data, albeit weak and outdated, did not always support the routine use of PN in the early phase of critical illness. Importantly, the more recent evidence about the safety and efficacy of PN
- might make physicians more comfortable with prescribing PN earlier to bridge the gap between nutrition goals and actual delivery of energy and protein. This might be especially for
- patients at high nutritional risk, or patients with an increased risk for prolonged ICU stay. In this context, we are proposing the
- EFFORTcombo trial that evaluates the effects of an early combined EN +high-protein PN nutrition strategy to decrease the nutritional deficiencies in the critically ill patients at nutritional risk. We hypothesise that this nutritional strategy will improve the functional outcomes of these nutritionally high-risk patients.

Conclusion

- broad range of adverse effects from limited research (observational data with small participant size and expert opinions).
- lifesaving therapeutic in patients with kidney disease.
- The prevention and management of TPN-KD involves careful monitoring of electrolyte imbalances and adjusting the composition of the TPN solution accordingly.
- Patients with underlying comorbidities such as diabetes and preexisting kidney disease are at higher risk of developing TPN-KD. Therefore, close monitoring of kidney function is essential in these patients to detect
- and manage TPN-related kidney dysfunction early. Acute kidney injury can be reversible with appropriate management, such as adjusting the composition and rate of TPN administration and correcting electrolyte imbalances. However, if lef
- untreated, TPN-KD can progress to CKD and irreversible kidney failure.93