Iranian Journal of NEUROSURGERY

Issue 3 and 4, No 18 and 19

Research Paper:

The Role of Dietitianin in Improving Energy and Protein Intake in TBI Patients Admitted to the Neurosurgical ICU

Fatemeh Ramezani Kapourchali[1,2], Ali Malekshahi Moghadam[3], Anoush Dehnadi Moghadam[4], Shahrokh Yousefzadeh-Chabok[2,5], Fatemeh Toorang[6], Mohammad Hassan Javanbakht[7], Sara Ramezani[2,8*]

1. Department of Inflammation and Immunity, Lerner Research Institute, Cleveland Clinic, Cleveland, OH, US
2. Guilan Road Trauma Research Center, Guilan University of Medical Sciences, Rasht, Iran
3. Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran
4. Department of Anesthesiology, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran
5. Department of Neurosurgery, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran
6. Cancer Research Center, Cancer Institute of Iran, Tehran University of Medical Sciences, Tehran, Iran
7. Department of Cellular and Molecular Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences, Tehran, Iran
8. Neuroscience Research Center, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran

Use your device to scan and read the article online

Citation: Ramezani Kapourchali F, Malekshahi Moghadam A, Dehnadi Moghadam A, Yousefzadeh-Chabok Sh, Toorang F, Javanbakht MH, et al. The Role of Dietitianin in Improving Energy and Protein Intake in TBI Patients Admitted to the Neurosurgical ICU. Iran J Neurosurg. 2019; 5(3):109-116. http://dx.doi.org/10.32598/irjns.5.3.3

http://dx.doi.org/10.32598/irjns.5.3.3

Article info:
Received: 10 Jan 2019
Accepted: 19 May 2019
Available Online: 01 Jul 2019

Keywords:
Dietitians, Enteral tube feeding, Intensive care unit (ICU), Nutritional and clinical assessments, Traumatic brain injury

ABSTRACT

Background and Aim: Early and sufficient nutritional support is vital to improve outcomes in patients with traumatic brain injury. This study aims to determine the effects of dietitian involvement in the nutritional and clinical outcomes in patients with traumatic brain injuries admitted to the neurosurgical ICU.

Methods and Materials/Patients: Forty-eight male patients with traumatic brain injuries admitted to neurosurgical ICU of Poursina Hospital, Rasht were studied retrospectively. Patients were divided to either receive dietitian intervention or remain without any nutritional recommendation (control). Demographic information, Glasgow Coma Scale and Acute Physiology and Chronic Health Evaluation II (APACHE II) scores, the timing of initial enteral feeding, the amount of energy and protein intake on day 4, the duration of mechanical ventilation and ICU length of stay were recorded.

Results: Patients under the dietitian recommendation had significantly lower timing of initial enteral nutrition compared to the other cases (P=0.02). The average energy or protein intake and the percentage of target energy or protein intake on day 4 appeared to be significantly lower in the subjects in the control group than in those with nutritional intervention (P≤0.001). There was no statistically significant difference in the duration of mechanical ventilation and ICU length of stay between different groups of patients.

Conclusion: Instead of occasional consultations for exclusive cases, the daily attendance of dietitians during multidisciplinary rounds of ICU is required to assess the nutritional needs of patients.

*** Corresponding Author:**
Sara Ramezani, PhD.
Address: *Neuroscience Research Center, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran*
Tel: *+98 (13) 33368773*
E-mail: *s.ramezanislp@gmail.com*

Iranian Journal of NEUROSURGERY

Highlights

- Dietitian intervention increased the average energy and protein intake and reduced the timing of initial enteral nutrition in patients with traumatic brain injury.

- Patients with traumatic brain injury received a higher percentage of target energy or protein intake on day 4 compared to those without dietitian intervention.

Plain Language Summary

Early and enough feeding is important for patients with traumatic brain injury to have a better outcome. Dietitian plays a role to tailor the feeding with the patient's requirement and level of tolerance. However, using dietitian recommendation is not routine in many hospitals for patients receiving tube feeding. In this study, we determined whether using dietitian recommendations can benefit the nutritional and clinical outcomes in patients with traumatic brain injury in the Intensive Care Unit (ICU). We found that dietitian presence in ICU increased the average of energy and protein intake and reduced the timing of feeding in patients compared to those who did not receive dietitian interventions. Patients in the dietitian group also consumed a higher percentage of their required energy and protein after 4 days. Patients in the dietitian group did not have better outcomes than those without dietitian intervention. It seems that dietitians in ICU may benefit the nutritional outcomes in patients with brain trauma.

1. Introduction

Traumatic Brain Injury (TBI) caused by road traffic accidents is prevalent in Guilan, a province in northern Iran [1]. Injuries with a varying severity in TBI patients admitted to Poursina Hospital, the biggest trauma center in Guilan, have been reported. Surgical intervention may be required in some cases [2]. However, the majority of TBI victims with moderate injury and all severe TBI patients, having a low level of consciousness, are currently managed in the intensive care unit (ICU) [3, 4]. Enteral Nutrition (EN) and parenteral nutrition (PN) are pivotal in the management of TBI in ICU because patients with such damages are unable to eat sufficiently [5].

Under these conditions, the Resting Energy Expenditure (REE) increases up to 40% [6]. Failure to provide adequate amounts of energy during the first 4 days after ICU admission may lead to malnutrition [7]. Significant weight loss was reported in 68% of TBI patients 6 months after the damage, most likely because of reduced energy intake [8]. An imbalanced nutritional status leading to malnutrition was described in majority of critically ill patients during their stay in ICU [9]. Increased morbidity and mortality can be attributed to the malnutrition in these patients that makes nutritional support a vital element of their care [10].

The multidisciplinary team approach in ICU has been demonstrated to improve cost-effectiveness and patients' outcomes. As a member of a multidisciplinary team, dietitians are educators, researchers, and translators of evidence-based guidelines into clinical practice. Dietitians in ICUs are qualified to assess patients' nutritional needs, tailor the nutritional care plan to the disease condition and patients' state, and recommend the best specialized enteral products to be used to achieve optimal blood glucose control. They also can provide an essential resource related to the route and timing of nutritional support and the prevention of possible complications leading to reduced energy intake, including imbalanced fluid and electrolyte, aspiration and diarrhea.

Dietitians can help to train students in a teaching hospital setting and finally conduct research design and analyze the data to improve the quality of care of ICU patients [10]. Although the role of ICU dietitians has evolved in past years, many ICUs in Iran still lack the dietitians with expertise and practice. Moreover, physicians often do not follow dietitians' recommendations, unless they directly contact physicians to implement the suggested treatment plan [11]. Findings in more than 150 ICUs around the world demonstrate that healthcare centers with the presence of dietitians have the best performance and higher ranking in critical care nutrition practice [12]. Incorporating the dietitians specialized in nutritional support in ICU improved energy and protein intake leading to better outcomes [13] and reduced costs [14].

The objective of this study was to investigate the impact of dietitians' involvement in nutritional outcomes, including the timing of initial enteral nutrition, the average and the percentage of target energy and protein intake on day 4 among TBI patients admitted to Neuro-ICU. Moreover, the clinical outcomes, including the duration of mechanical ventilation and ICU Length of Stay (ILOS), were evaluated in cases as secondary endpoints.

2. Methods and Materials/Patients

The patients with TBI admitted to Neuro-ICU of Poursina Hospital for three years, were reviewed retrospectively in this study. Forty-eight patients were selected into the study if they were eligible. Inclusion criteria were defined as follows: Glasgow Coma Scale (GCS) score between 6 and 12, Acute Physiology And Chronic Health Evaluation II (APACHE II) score higher than 11 [15], and hospitalization in the Neuro-ICU for more than 48 h. Exclusion criteria included being female, ages younger than 18 and older than 60, having spinal cord injury, having metabolic disorders such as diabetes, thyroid and chronic kidney diseases, and absolute contraindications for enteral feeding, e.g. paralytic ileus, intestinal obstruction, short bowel syndrome, and active Gastrointestinal (GI) bleeding.

Subjects intravenously nourished with amino acids, albumin or fat emulsion during the 4 days after initiation of enteral feeding were also excluded from the study. All patients admitted to the ICU are routinely subject to ICU team collaboration. The ICU team consisted of nurses, pharmacists, and physicians. A research dietitian who conducted some research assessing the nutritional status of patients and microbial quality of the formula [16] joined the ICU team as a dietitian-nutritionist, and dietitian recommendations were received by those patients admitted to the hospital. Patients admitted to ICU before this time were classified as the control group. The study protocol was performed following the guidelines of the Medical Ethics Committee of Guilan University of Medical Sciences, Rasht, Iran, after obtaining written consent from a family member when the patient was not conscious.

Dietitian assessment and interventions

The assessment of nutritional status and the evaluation of the nutritional and microbial quality of enteral nutrition solutions were conducted before starting some interventions [16]. The interventions were designed by expert dietitians in the ICU team for advanced nutritional assessment and counseling, while there were no guidelines or written goals for formula intake in patients receiving enteral tube feeding in the Neuro-ICU. The patients' nutrition information was collected both on and after admission on a daily basis and identified in shift change time every morning by the dietitian to give some information from nutrition's point of view, such as the nutritional status, nutritional requirement, and recommendation for taking proper fluid, nutrients, and regulating proper timing to initiate or continue enteral feeding. Moreover, the dietitian altered the enteral solution components to increase energy density.

Glutamine powder, as the source of nutrient for enterocytes [17], was added to the enteral solutions. Before dietitian's involvement in the ICU team, feeding formula consisted of a mixture of natural foods with vitamins and Ensure® Nutrition Powder (Abbott Nutrition, Columbus, Ohio, USA) containing 645 kcal/L (35 g protein/L). By adding more proportion of Ensure® Nutrition Powder and glutamine (10 g/L), the dietitian increased the energy and protein density of the enteral formulato 990 kcal/L (60 g protein/L). The alterations were designed to achieve the ultimate goals of daily protein and energy requirements estimated from 1.5-2 g/kg [5] and from 25-30 kcal/Kg [18], respectively, according to the recommendations. During the study, all patients received intravenous dextrose water, if it was required to calculate and include their energy contents.

Data collection

Basic patient characteristics, including age and weight, as well as GCS and APACHE II scores within 24 h after admission and timing of initial enteral feeding, were recorded. The volume of formula delivered to the cases during 4 days was determined to calculate the daily energy and protein intake. Administration of high-dose tube feeding was defined as ≥60% of target energy needs [19]. Additionally, clinical parameters including ILOS and the duration of mechanical ventilation were registered for all patients.

Statistical analysis

All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) software V. 22. Independent t-test and Chi-Square test were used to compare quantitative and nominal qualitative variables, respectively. A P-value less than 0.05 was considered statistically significant. Data were expressed as Mean±SD.

3. Results

Basic characteristics

The baseline and clinical characteristics of the 48 patients enrolled in the study are summarised in Table 1. There were no significant differences in age, weight and APACHEII and GCS scores among the study participants.

Nutritional outcomes

The patients' nutritional outcomes of enteral nutrition provided for both groups are shown in Table 2. Patients under the dietitian recommendations had significantly lower timing of initial enteral nutrition compared to the other cases (67 vs. 93 h, P=0.02). There was a statistically significant difference in average energy intake on day 4 between the control and dietitian intervention groups (880 vs. 1280 kcal, P≤0.001). In agreement with our findings, the percentage of target energy intake on day 4 was found to be significantly higher among patients under the dietitian interventions, compared with the controls (53.61 vs. 31.60%, P≤0.001).

As shown in Table 2, the difference between the two groups in protein intake on day 4 was considered to be statistically significant (37.10 vs. 69.50g, P≤0.001). Furthermore, the percentage of target protein intake on day 4 appeared to be significantly lower in patients in the control group than in those receiving interventions (34.57 vs. 64.99%, P≤0.001). The average volume of formula delivered to patients on day 4 was not statistically different between the two groups of cases (1368 vs. 1294 mL, P=0.33). In this study, 8% and 37% of subjects in the control groups and interventional groups received more than 60% of their energy requirements, respectively (K^2=5.77, P=0.01). No death was observed between the groups of patients during the present study.

Clinical outcomes

The clinical outcomes of both groups are shown in Table 2. There was no statistically significant difference in the duration of mechanical ventilation between the groups (12.50 vs. 11.16 days, P=0.59). Although patients under the dietitian recommendations had lower ILOS compared to the controls (14.20 vs. 16.16 days), this difference was not significant. Additionally, after removing the effects of age, gender, GCS, and APACHE

Table 1. The baseline and clinical characteristics of the groups on ICU admission (n=24)

Variables	Control	Dietitian Intervention	P
Age (y)	40.25±6.15	37.33±8.56	0.18
Weight (kg)	72.29±9.55	71.87±10.51	0.88
GCS score	7.00±1.69	7.50±1.97	0.35
APACHE II score	18.58±3.83	21.20±5.48	0.06

ICU: intensive care unit; GCS: Glasgow Coma Scale; APACHE: Acute Physiology and Chronic Health Evaluation.

Table 2. Nutritional and clinical outcomes in the different groups of patients (n=24)

Variables	Mean±SD		P
	Control	Dietitian Intervention	
Timing of enteral feeding initiation (h)	93.00±40.22	67.00±36.07	0.02
Energy intake on day 1 (Kcal)	320.00±70.00	480.00±90.00	0.01
Energy intake on day 4 (Kcal)	880.00±280.00	1280.00±240.00	≤0.001
% of target caloric intake on day 4	31.60±12.79	53.61±12.54	≤0.001
Protein intake on day 1 (g)	25.82±8.23	32.08±8.35	0.01
Protein intake on day 4 (g)	47.10±16.43	75.50±15.65	≤0.001
% of target protein intake on day 4	34.57±13.99	64.99±15.20	≤0.001
Delivered formula on day 4 (ml)	1368.00±469.58	1294.00±237.00	0.33
Duration of mechanical ventilation (d)	12.50±7.56	11.16±9.47	0.59
ILOS (d)	16.16 (8.50)	14.20 (10.21)	0.47

ILOS: ICU (intensive care unit) length of stay

II scores, there was no statistically significant difference in duration of mechanical ventilation and ILOS between the two groups of cases.

4. Discussion

This study investigated the influences of dietitian's involvement in the ICU team in the nutritional and clinical outcomes among head injury cases in the Neuro-ICU. Dietitian involvement in the ICU setting increased energy and protein intake on day 4, reduced the timing of initial feeding and potentially improved clinical outcomes in TBI patients. Overall, results indicated the importance of a dietitian as a member of the ICU team.

Nutritional outcomes

In this study, it has been shown that patients in the dietitian group had significantly lower timing of initial enteral nutrition compared to the other subjects in the control group. Nutrition is the fundamental of critical care support among TBI patients. Brain Trauma Foundation (BTF) recommends initiation of tube feeding no later than 72 h after trauma in TBI cases [20]. This provides sufficient time to assess risks including hemodynamic instability, large-volume fluid resuscitation or bowel distension [21]. Previous studies have demonstrated the beneficial effects of the presence of clinical nutritionists in the ICU teams in terms of the average time to start enteral nutrition [22]. Therefore, dietitian recommendations in ICU lead to decrease in the feeding time, following the BTF.

The average and the percentage of target energy or protein intake on day 4 have been shown to be significantly lower in controls than those of the dietitian group. These results confirm the preceding researches that the dietitian recommendations lead to higher energy intake [23], support the individual nutritional requirements and case care [12, 24-26]. Higher energy and protein intake in patients receiving dietitian recommendations on day 4 compared to those in controls seems to be mostly related to the enteral formula with high energy and protein as no significant changes were observed in the average volume of formula delivered to patients on day 4 between two groups of cases. The beneficial impacts of high-calorie and protein-dense formulas on a daily intake of tube-fed patients have been demonstrated in another research [27].

Generally, there are several interruptions in ICUs, including fasting for specific clinical procedures and tube feeding intolerance, which make delivery of prescribed formulas difficult [22, 28]. TBI patients have an intolerance to enteral feeding in the first 2 weeks after admission for a variety of reasons [5] including reduced GI mobility and delayed gastric emptying that can result in elevated gastric residual volume and gastro-oesophageal reflux disease [29]. To increase the delivery of enteral nutrition, barriers such as intolerance to tube feeding could be controlled using a standardized protocol, including measurement of gastric retention [30-32].

Although there are more than 40 clinical guidelines for TBI identified at the National Guideline Clearing house online database, they mostly concentrate on emergency department treatment. There are only few guidelines to address nutritional concerns related to TBI [33] 'publisher': National Academies Press (US. In addition, lack of sufficient nutritional medicine courses [34] might lead to the inappropriate prescription of enteral formulas by physicians, which is one of the most common reasons for underfeeding in critically ill patients [35].

Clinical outcomes

In the present study, there was no statistically significant difference in the duration of mechanical ventilation and ILOS between two groups of cases. Dietitian recommendations gave rise to a significant decrease in ILOS within the first 3 days [10, 36], but the mechanical ventilation did not reduce [37]. Likewise, concordant with our results, Minard et al., (2000) reported no significant difference in ICU stay between early and late tube-fed patients [38].

A number of studies have shown that enteral nutrition with an enhanced immune formula [39], or tube feeding via the jejunum [40] or both [41], significantly reduces ILOS in a timely manner (within 18-36 h after trauma). Although decreased significantly in the dietitian group, the average initial time for enteral nutrition is defined as late feeding according to the American Society for Parenteral and Enteral Nutrition (ASPEN) guidelines that evaluate the feeding launched over 48 h after ICU admission as late feeding [14].

In agreement with our findings, some researches have demonstrated no impact of early enteral nutrition (in the first 6–24 h) on ILOS or duration of mechanical ventilation [42, 43]. The discrepancy between these findings might be explained by differences in the populations, severity of the trauma, and routes and times of administration.

Some limitations should be regarded when interpreting the findings of the present study. First, the sample

size limits the study's power to analyze the measured outcomes. Second, we were not completely able to account for the role of confounding factors, including cerebral edema, intracranial pressure, and systemic injuries. Another limitation of our work was that we could not include female population in this study. Finally, intolerance to tube feeding in patients could not be recorded with detailed information.

Randomized Controlled Trials (RCTs) with mixed ICU patients which include both males and females are required to investigate the role of dietitian recommendations on the nutritional and clinical outcomes among TBI patients. Enteral feeding protocols are suggested to be implemented in intensive care units of Iran. We also recommend to conduct the present study with larger sample size and longer follow-up time.

5. Conclusion

This study indicated the importance of a dietitian as a member of the ICU team. Dietitian recommendations in the ICU setting raised energy and protein intake and reduced the timing of initial feeding in TBI patients. However, these enhanced results were still not satisfactory for clinical outcomes. Based on the findings of this project, it seems that the daily attendance of dietitians during a multidisciplinary shift change in ICU may be required to assess the nutritional needs of patients, particularly in the first week of admission.

Ethical Considerations

Compliance with ethical guidelines

Written informed consent was obtained from all patients or from their family members when the patient was not conscious.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors contributions

Conceptualization and methodology: Fatemeh Ramezani Kapourchali, Ali Malekshahi Moghadam, Anoush Dehnadi Moghadam, Shahrokh Yousefzadeh-Chabok, Fatemeh Toorang; Data collection: Fatemeh Ramezani Kapourchali, Ali Malekshahi Moghadam, Fatemeh Toorang; Data Analysis: Fatemeh Ramezani Kapourchali; Drafting the article: Fatemeh Ramezani Kapourchali; Critically revising the article: Sara Ramezani, Shahrokh Yousefzadeh-Chabok; Reviewing the submitted version of manuscript and Approving the final version of the manuscript: All authors.

Conflict of interest

The authors declared no conflict of interest.

References

[1] Chabok SY, Kapourchali SR, Leili EK, Saberi A, Mohtasham-Amiri Z. Effective factors on linguistic disorder during acute phase following traumatic brain injury in adults. Neuropsychologia. 2012; 50(7):1444-50. [DOI:10.1016/j.neuropsychologia.2012.02.029] [PMID]

[2] Chabok SY, Kapourchali SR, Saberi A, Mohtasham-Amiri Z. Operative and nonoperative linguistic outcomes in brain injury patients. Journal of the Neurological Sciences. 2012; 317(1-2):130-6. [DOI:10.1016/j.jns.2012.02.009] [PMID]

[3] Jochems D, van Wessem K, Houwert R, Brouwers H, Dankbaar J, van Es M, et al. Outcome in patients with isolated moderate to severe traumatic brain injury. Critical Care Research and Practice. 2018; 2018:3769418. [DOI:10.1155/2018/3769418] [PMID] [PMCID]

[4] Nishijima DK, Sena MJ, Holmes JF. Identification of low risk patients with traumatic brain injury and intracranial hemorrhage who do not need intensive care unit admission. The Journal of Trauma. 2011; 70(6):E101-7. [DOI:10.1097/TA.0b013e3181e88bcb] [PMID] [PMCID]

[5] Cook AM, Peppard A, Magnuson B. Nutrition considerations in traumatic brain injury. Nutrition in Clinical Practice. 2008; 23(6):608-20. [DOI:10.1177/0884533608326060] [PMID]

[6] Militsa B. Nutrition in neurologic and neurosurgical critical care. Neurology India. 2001; 49:S75-9.

[7] Payne-James J, Grimble GK, Silk DB. Artificial nutrition and support in clinical practice. Cambridge: Cambridge University Press; 2012.

[8] Krakau K, Hansson A, Karlsson T, de Boussard CN, Tengvar C, Borg J. Nutritional treatment of patients with severe traumatic brain injury during the first six months after injury. Nutrition. 2007; 23(4):308-17. [DOI:10.1016/j.nut.2007.01.010] [PMID]

[9] Barr J, Hecht M, Flavin KE, Khorana A, Gould MK. Outcomes in critically ill patients before and after the implementation of an evidence-based nutritional management protocol. Chest. 2004; 125(4):1446-57. [DOI:10.1378/chest.125.4.1446] [PMID]

[10] Taylor B, Renfro A, Mehringer L. The role of the dietitian in the intensive care unit. Current Opinion in Clinical Nutrition & Metabolic Care. 2005; 8(2):211-6. [DOI:10.1097/00075197-200503000-00017] [PMID]

[11] Skipper A, Young M, Rotman N, Nagl H. Physicians' implementation of dietitians' recommendations: A study of the effectiveness of dietitians. Journal of the American Dietetic Association. 1994; 94(1):45-9. [DOI:10.1016/0002-8223(94)92039-7]

[12] Heyland DK, Heyland RD, Cahill NE, Dhaliwal R, Day AG, Jiang X, et al. Creating a culture of clinical excellence in critical care nutrition: The 2008 "Best of the Best" award. Journal of Parenteral and Enteral Nutrition. 2010; 34(6):707-15. [DOI:10.1177/0148607110361901] [PMID]

[13] Ochoa JB, Magnuson B, Swintowsky M, Loan T, Boulanger B, McClain C, et al. Long-term reduction in the cost of nutritional intervention achieved by a nutrition support service. Nutrition in Clinical Practice. 2000; 15(4):174-80. [DOI:10.1177/088453360001500404]

[14] Johansen N, Kondrup J, Plum LM, Bak L, Nørregaard P, Bunch E, et al. Effect of nutritional support on clinical outcome in patients at nutritional risk. Clinical Nutrition. 2004; 23(4):539-50. [DOI:10.1016/j.clnu.2003.10.008] [PMID]

[15] Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: A severity of disease classification system. Critical Care Medicine. 1985; 13(10):818-29. [DOI:10.1097/00003246-198510000-00009] [PMID]

[16] Moghadam AD, Chabok SY, Ramezani F, Leili EK, Rahimi V. [Evaluation of nutritional quality and microbial contamination of enteral feeding solutions in hospitalized patients referred to neurosurgical ICU of Poursina Hospital in Rasht (Persian)]. Pejouhandeh. 2010; 15(5):213-9.

[17] Kim MH, Kim H. The roles of glutamine in the intestine and its implication in intestinal diseases. International Journal of Molecular Sciences. 2017; 18(5):pii:E1051. [DOI:10.3390/ijms18051051] [PMID] [PMCID]

[18] Kreymann K, Berger M, Deutz Ne, Hiesmayr M, Jolliet P, Kazandjiev G, et al. ESPEN guidelines on enteral nutrition: Intensive care. Clinical Nutrition. 2006; 25(2):210-23. [DOI:10.1016/j.clnu.2006.01.021] [PMID]

[19] McClave SA, Martindale RG, Vanek VW, McCarthy M, Roberts P, Taylor B, et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (ASPEN). Journal of Parenteral and Enteral Nutrition. 2009; 33(3):277-316. [DOI:10.1177/0148607109335234] [PMID]

[20] Brain TF. Guidelines for the management of severe traumatic brain injury. X. Brain oxygen monitoring and thresholds. Journal of Neurotrauma. 2007; 24 (Suppl 1):S65-S70.

[21] Kattelmann KK, Hise M, Russell M, Charney P, Stokes M, Compher C. Preliminary evidence for a medical nutrition therapy protocol: Enteral feedings for critically ill patients. Journal of the American Dietetic Association. 2006; 106(8):1226-41. [DOI:10.1016/j.jada.2006.05.320] [PMID]

[22] Mansfield AN. Nutrition support protocols and early feeding in the intensive care unit. [MSc Thesis]. Ohio: Bowling Green State University; 2008.

[23] Soguel L, Revelly JP, Schaller MD, Longchamp C, Berger MM. Energy deficit and length of hospital stay can be reduced by a two-step quality improvement of nutrition therapy: The intensive care unit dietitian can make the difference. Critical Care Medicine. 2012; 40(2):412-9. [DOI:10.1097/CCM.0b013e31822f0ad7] [PMID]

[24] Moreland K, Gotfried M, Vaughan L. Development and implementation of the clinical privileges for dietitian nutrition order writing program at a long-term acute-care hospital. Journal of the American Dietetic Association. 2002; 102(1):72-81. [DOI:10.1016/S0002-8223(02)90021-0]

[25] Olsen IE, Richardson DK, Schmid CH, Ausman LM, Dwyer JT. Dietitian involvement in the neonatal intensive care unit: more is better. Journal of the American Dietetic Association. 2005; 105(8):1224-30. [DOI:10.1016/j.jada.2005.05.012] [PMID]

[26] Weddle DO, Tu NS, Guzik CJ, Ramakrishnan V. Positive association between dietetics recommendations and achievement of enteral nutrition outcomes of care. Journal of the American Dietetic Association. 1995; 95(7):753-8. [DOI:10.1016/S0002-8223(95)00210-3]

[27] Binnekade JM, Tepaske R, Bruynzeel P, Mathus-Vliegen EM, de Haan RJ. Daily enteral feeding practice on the ICU: Attainment of goals and interfering factors. Critical Care. 2005; 9(3):R218-25. [DOI:10.1186/cc3504] [PMID] [PMCID]

[28] Petros S, Engelmann L. Enteral nutrition delivery and energy expenditure in medical intensive care patients. Clinical Nutrition. 2006; 25(1):51-9. [DOI:10.1016/j.clnu.2005.08.013] [PMID]

[29] Tan YA, Sambanthamurthi R, Sundram K, Wahid MB. Valorisation of palm by-products as functional components. European Journal of Lipid Science and Technology. 2007; 109(4):380-93. [DOI:10.1002/ejlt.200600251]

[30] Heyland DK, Cahill NE, Dhaliwal R, Sun X, Day AG, McClave SA. Impact of enteral feeding protocols on enteral nutrition delivery: Results of a multicenter observational study. Journal of Parenteral and Enteral Nutrition. 2010; 34(6):675-84. [DOI:10.1177/0148607110364843] [PMID]

[31] Spain DA, McClave SA, Sexton LK, Adams JL, Blanford BS, Sullins ME, et al. Infusion protocol improves delivery of enteral tube feeding in the critical care unit. Journal of Parenteral and Enteral Nutrition. 1999; 23(5):288-92. [DOI:10.1177/014860719902300528] [PMID]

[32] Wøien H, Bjørk IT. Nutrition of the critically ill patient and effects of implementing a nutritional support algorithm in ICU. Journal of Clinical Nursing. 2006; 15(2):168-77. [DOI:10.1111/j.1365-2702.2006.01262.x] [PMID]

[33] Bistrian BR, Askew W, Erdman Jr JW, Oria MP. Nutrition and traumatic brain injury: A perspective from the Institute of Medicine report. Journal of Parenteral and Enteral Nutrition. 2011; 35(5):556-9. [DOI:10.1177/0148607111416122] [PMID]

[34] Hosseini S, Nayebi N, Amirkalali B, Seyedkhoei N, Heshmat R. Are physicians good candidates for recommending diet? Iranian Journal of Public Health. 2008; 37(1):48-53.

[35] Kim H, Choi-Kwon S. Changes in nutritional status in ICU patients receiving enteral tube feeding: A prospective descriptive study. Intensive and Critical Care Nursing. 2011; 27(4):194-201. [DOI:10.1016/j.iccn.2011.05.002] [PMID]

[36] Braga JM, Hunt A, Pope J, Molaison E. Implementation of dietitian recommendations for enteral nutrition results in improved outcomes. Journal of the American Dietetic Association. 2006; 106(2):281-4. [DOI:10.1016/j.jada.2005.10.039] [PMID]

[37] Roberts SR, Kennerly DA, Keane D, George C. Nutrition support in the intensive care unit adequacy, timeliness, and outcomes. Critical Care Nurse. 2003; 23(6):49-57. [DOI:10.4037/ccn2003.23.6.49] [PMID]

[38] Minard G, Kudsk KA, Melton S, Patton JH, Tolley EA. Early versus delayed feeding with an immune-enhancing diet in patients with severe head injuries. Journal of Parenteral and Enteral Nutrition. 2000; 24(3):145-9. [DOI:10.1177/0148607100024003145] [PMID]

[39] Taylor SJ, Fettes SB, Jewkes C, Nelson RJ. Prospective, randomized, controlled trial to determine the effect of early enhanced enteral nutrition on clinical outcome in mechanically ventilated patients suffering head injury. Critical Care Medicine. 1999; 27(11):2525-31. [DOI:10.1097/00003246-199911000-00033] [PMID]

[40] Grahm TW, Zadrozny DB, Harrington T. The benefits of early jejunal hyperalimentation in the head-injured patient. Neurosurgery. 1989; 25(5):729-35. [DOI:10.1097/00006123-198911000-00007] [PMID]

[41] Moore EE, Jones TN. Benefits of immediate jejunostomy feeding after major abdominal trauma: A prospective, randomized study. The Journal of Trauma. 1986; 26(10):874-81. [DOI:10.1097/00005373-198610000-00003] [PMID]

[42] Eyer SD, Micon LT, Konstantinides FN, Edlund DA, Rooney KA, Luxenberg MG, et al. Early enteral feeding does not attenuate metabolic response after blunt trauma. The Journal of Trauma. 1993; 34(5):639-43. [DOI:10.1097/00005373-199305000-00005] [PMID]

[43] Kompan L, Kremžvar B, Gadžvijev E, Prošek M. Effects of early enteral nutrition on intestinal permeability and the development of multiple organ failure after multiple injury. Intensive Care Medicine. 1999; 25(2):157-61. [DOI:10.1007/s001340050809] [PMID]