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Original Article

Determination of calorie and protein intake among acute and sub-acute traumatic brain injury patients

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ABSTRACT

Purpose: Malnutrition is a common problem among hospitalized patients, especially among traumatic brain injury (TBI) patients. It is developed from hypermetabolism and the condition may worsen under the circumstance of underfeeding or incompatible dietary management. However, the data of nutrient intake especially calorie and protein among TBI patients were scarce. Hence, this study aimed to determine the calorie and protein intake among acute and sub-acute TBI patients receiving medical nutrition therapy in hospital Sultanah Nur Zahirah, Terengganu.

Methods: This observational study involved 50 patients recruited from the neurosurgical ward. Method of 24 h dietary recall was utilized and combined with self-administered food diaries for 2–8 days. Food consumptions including calorie intake and protein intake were analyzed using Nutritionist PRO™ (Woodinville, USA) and manual calculation based on the Malaysian food composition database (2015).

Results: Patients consisted of 56% males and 44% females with the median age of 28.0 (IQR = 22.8-36.5) years, of which 92% were diagnosed as mild TBI and the remaining (8%) as moderate TBI. The Glasgow coma scale (GCS) was adopted to classify TBI severity with the score 13–15 being mild and 9–12 being moderate. The median length of hospital stay was 2 (IQR = 2.0–3.3) days. Calorie and protein intake improved significantly from day 1 to discharge day. However, the intake during discharge day was still considered as suboptimal, i.e. 75% of calorie requirement, whilst the median protein intake was only 61.3% relative to protein requirement. Moreover, the average percentages of calorie and protein intakes throughout hospitalization were remarkably lower, i.e. 52.2% and 41.0%, respectively.

Conclusion: Although the calorie and protein intakes had increased from baseline, hospitalized TBI patients were still at a risk to develop malnutrition as the average intakes were considerably low as compared to their requirements. Optimum nutrient intakes especially calorie and protein are crucial to ensure optimum recovery process as well as to minimize risks of infection and complications.

Introduction

Traumatic brain injury (TBI) can be defined as an intracranial injury due to an external force exerted on the brain. Acute and sub-acute TBI refer to the duration of post-injury ≤ 7 days, and 8 days-3 months, respectively.[1,2] TBI patients who go to the emergency department usually need to be hospitalized at least a night for monitoring, in which an increase in severity or disability can prolong the length of stay (LOS). Malnutrition is expected as a common sequel among hospitalized patients. Previously, the prevalence of malnutrition in hospitalized patients was reported to range from 20% to 50%, but the prevalence of malnutrition among hospitalized TBI patients is still unknown.[3–5] TBI patient is likely to develop malnutrition due to excessive protein break down and high calorie demand resulting in negative nitrogen balance, in addition to increased requirements of protein and calorie.[6,7]

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TBI results in primary and secondary injuries which may lead to temporary or permanent neurological deficits.[8] Generally, the injury causes abnormality of cellular metabolism, hormonal changes, and systemic inflammation response. Calorie expenditure among TBI patients usually increase by 87%–200% above the usual requirement and may be elevated for 30 days due to metabolic changes.[6,9] Hormonal changes increase the production of corticosteroids, counter-regulation hormones, and cytokines which may cause the patient to develop hyper-metabolism state.[10–12] Furthermore, a lot of physiological challenges may alter their calorie needs.[13] The alteration of systematic catabolism of the body will lead to hyperglycemia, protein wasting and increased calorie demands.[12]

The injuries could be avoided or minimized through early interventions including medical nutrition therapy (MNT) to restore optimal nutritional status,[14,15] by providing sufficient nutrients for the recovery process[9] and reducing the catabolic response and prolonged hypermetabolism.[13] A previous study found that critically-ill patient who was on enteral feeding consumed approximately 50%–60% calorie and 56%–60% protein compared to their requirement.[16–19] A recent study by Steward et al.[20] among critically-ill patients in the United State revealed that approximately 20% of calorie and 17% of protein were consumed relatively to their requirements, respectively. Additionally, calorie and protein deficit among moderate to severe TBI (Glasgow coma scale (GCS) score 9–12 and 3–8, respectively) patients were accumulated at 18,242 kcal (1 kcal = 4.186 kJ) and 1315 g protein, respectively.[21] However, the intake among mild to moderate acute TBI in the surgical ward was not established yet. Hence, this study aimed to determine the intake of calorie and protein as baseline data, so that early and appropriate MNT could be planned and prescribed according to the patients' actual requirement.

Methods

The research was an observational cross-sectional study. Fifty respondents aged from 20 to 60 years, diagnosed with mild or moderate TBI were recruited from surgical ward in hospital Sultanah Nur Zahirah, Kuala Terengganu. Patients who were on parenteral nutrition, suffered multiple injuries or had a history of neurological or psychiatric problems were excluded.

After obtaining the written informed consent, a brief introduction of the study was given. Demography data including age, level of education (LOE) and occupation were interviewed and counter-checked with hospital information system for clarification. Anthropometry assessments such as body weight and height were measured. For immobilized or bedridden patients, body weight and height were estimated by predictive calculation using a proxy of knee height and mid-arm muscle circumference. Using body-weight, height and age, with appropriate injury and activity factor, calorie requirement was determined based on the researches of Benedict et al.[22] and Mifflin et al.,[23] whereby protein requirement was calculated using a weight-based formula.[24,25] Dietary intakes of patients were obtained from the 24 h dietary recall combined with a self-administered food diary to facilitate memorizing and counter-checking. The dietary intakes were recorded daily from day 1 until the discharge. Calorie and protein intake were analyzed from food analysis using Nutritionist PRO™ (Woodinville, USA) and manual calculation based on the Malaysian food composition database (2015).

Statistical analysis was conducted using SPSS software version 25 (IBM Corporation, USA). Descriptive analysis was done after checking the normality of data distribution. As the sample size was only 50 patients and the data were not normally distributed, results are presented in median and interquartile (IQR) and appropriate tests were done using non-parametric tests. The Wilcoxon signed-rank test was used to compare calorie and protein intake between day 1 and discharge day (the discharge day regardless of LOS). Comparison between gender, types of TBI, LOE, body mass index (BMI) category were done using Mann-Whitney or Kruskal Wallis test. The ethical clearance was granted by the Malaysian Research and Ethics Committee, Ministry of Health Malaysia [NMMR-16-1925-32387].

Results

Of 50 patients, 56% were male and 44% were female with a median age of 28.0 (IQR = 22.8–36.5) years. All were literate with the majority of them (80%) attained secondary education and 92% are working. The median height and body weights were 164.5 (IQR = 158.0–169.0) cm and 63.0 (IQR = 55.0–70.0) kg, respectively. The majority of respondents (56%) had a normal BMI (median BMI 23.2, IQR = 21.3–26.3). Forty-six respondents (92%) were suffering from mild TBI, whilst only four (8%) had moderate TBI, 88% of which had GCS of 15. The majority of them (92%) had TBI due to motor vehicle accidents whilst the remaining were due to violence and fall and were warded for 2 days (IQR = 2.0–3.3). Median calorie and protein requirements were 2232 kcal/day (IQR = 1977–2403) and 121.3 g/day (IQR = 108.2–130.0), respectively. Baseline data are summarized in Table 1.

Compared with the requirement, the intake of calorie and protein reached as low as 23.1% (approximately 516 kcal) and 14.8% (approximately 18.0 g) respectively on day 1. The rate increased to 75.0% (approximately 1674 kcal) and 61.3% (74.4 g) on the discharge day regardless of LOS. The average percentage of calorie and protein intakes throughout LOS was 55.2% and 41.3%. Median percentage of calorie and protein intake from day 1 to the discharge day is shown in Table 2.

Analysis of macronutrients showed that calorie consumed by respondents from carbohydrate was (55.5%), protein (17.3%) and fat (27.2%). Additionally, several factors were analyzed to explain any effect on calorie and protein intake (discharge day and the average) (Table 3). The percentage of calorie and protein intake were significantly associated with the type of TBI or severity, while gender only affected calorie intake of the discharge day.

Discussion

It was estimated that the prevalence of malnutrition was 50% and 43% among patients in the general ward and intensive care unit (ICU), respectively.[26] Globally, it constitutes approximately 22%–43% of hospitalized patients.[27–29] Upon admission, 15%–70% of patients were already suffering from malnutrition before hospitalization.[30] Although the data of malnutrition among hospitalized TBI patients are sparse, it is expected that this group of patients has a tendency to develop malnutrition as they usually require high calorie and protein to cater hypermetabolism and hypercatabolism states. The calorie and protein intake are generally not meeting the required amount due to various limiting factors. However, the actual calorie and protein intake data were scarce. Study of moderate to severe TBI patients found that the calorie and protein intake in the ward were 1980 kcal/day (standard deviation (SD) = 915) and 89 g/day (SD = 41), respectively, and it was lower in ICU which were only 1798 kcal/day (SD = 800) and 79 g/day (SD = 47), respectively.[21]

It may be difficult for TBI patients to achieve more than 80% of calorie intake due to pain and discomfort, and other co-injuries such as dental fractures, facial fractures, oral injuries and the need for prolonged cervical immobilization with a hard-cervical collar may delay initiation of an oral diet.[13] Additionally, they

Table 1
Baseline background of respondents ($n = 50$).

Variables	Value
Age (year)	28.0 (22.8–36.5)
Height (cm)	164.5 (158.0–169.0)
Weight (kg)	63.0 (55.0–70.0)
BMI	23.2 (21.3–26.3)
Calorie requirement (kcal/day)	2232 (1977.4–2403.1)
Protein requirement (g/day)	121.3 (108.2–130.0)
LOS (day)	2.0 (2.0–3.3)
Age group (year)	
Early adult (20–40)	40 (80)
Middle adult (41–60)	10 (20)
Gender	
Male	28 (56)
Female	22 (44)
LOE	
Secondary	40 (80)
Tertiary	10 (20)
Occupation	
Odd job	12 (24)
Student	11 (22)
Housewife	11 (22)
Government servant	7 (14)
Labor	5 (10)
Jobless	4 (8)
BMI class	
Underweight	3 (6)
Normal weight	28 (56)
Overweight	16 (32)
Obese	3 (6)
TBI severity	
miTBI	46 (92)
moTBI	4 (8)
GCS score	
9	1 (2)
10	1 (2)
11	1 (2)
12	1 (2)
13	1 (2)
14	1 (2)
15	44 (88)
Etiology	
MVA	46 (92)
Violence	2 (4)
Fall	2 (4)
Main area of brain injury	
Frontal	42 (84)
Parietal	2 (4)
Temporal	2 (4)
Occipital	3 (6)
Others	1 (2)

BMI: body mass index, LOS: length of stay, LOE:level of education, TBI: traumatic brain injury, miTBI: mild traumatic brain injury, moTBI: moderate traumatic brain injury, GCS: Glasgow coma scale, MVA: motor vehicle accident.
Data are presented as *n* (%) or median (IQR).

Table 2
Median percentage of calorie and protein intake of 50 respondents from day 1 to the discharge day, median (IQR).

Day	Calorie intake (%)	Protein intake (%)
1 ($n = 50$)	23.1 (0.0–53.8)	14.8 (0.0–40.6)
2 ($n = 50$)	70.1 (45.7–81.5)	57.6 (36.8–67.8)
3 ($n = 21$)	65.2 (44.4–75.3)	56.3 (33.8–62.0)
4 ($n = 11$)	61.0 (41.3–72.4)	48.7 (28.2–59.9)
5 ($n = 4$)	84.1 (49.3–107.4)	62.1 (35.7–69.2)
6 ($n = 3$)	97.1 (46.0-)	80.7 (32.9-)
7 ($n = 1$)	63.2 (63.2–63.2)	45.3 (45.3–45.3)
8 ($n = 1$)	63.2 (63.2–63.2)	59.0 (59.0–59.0)
Discharge day[a]	75.0 (64.1–84.5)	61.3 (53.6–70.4)
Average	55.2 (37.2–65.9)	41.3 (28.2–52.2)
p value	0.000[b]	0.000[b]

[a] Discharge day regardless of length of stay.
[b] Median difference between day 1 to discharge day using Wilcoxon sign-ranked test.

Table 3
p value of the effect of age group, gender, LOE, BMI class, type of TBI, etiology and area of brain injury on the percentage of calorie and protein intake during discharge day and the average.

Factors	Calorie intake		Protein intake	
	Discharge day	Average	Discharge day	Average
Age group[a]	0.356	1.000	0.839	0.607
Gender[a]	0.006[c]	0.159	0.118	0.253
LOE[b]	0.395	0.558	0.198	0.526
BMI class[b]	0.214	0.588	0.480	0.866
TBI severity[a]	0.142	0.017[c]	0.070	0.013[c]
Etiology[b]	0.550	0.414	0.468	0.451
Main area of brain injury[b]	0.172	0.727	0.212	0.630

LOE: level of education, BMI: body mass index, TBI: traumatic brain injury.
[a] Result of *p* value using Mann-Whitney test.
[b] Result of *p* value using Kruskal-Wallis test.
[c] Significant result ($p < 0.05$).

may experience eating behavior changes including loss of appetite secondary to psychological impairment, especially post-traumatic depression.[31] Furthermore, TBI patients who can consume orally are at risk of malnutrition primarily due to interruption of feeding such as fasting for surgery or procedure and patient-related reasons.[21] Inhibition of food intake also occurs due to physical aggression.[32]

This study aimed to determine the calorie and protein intake among TBI patients for an early and effective intervention which was tailored to their needs. Findings revealed that there was a remarkable increase of the calorie and protein intake from day 1 and day 2, which may be due to that the patients were allowed to resume meals after certain medical procedures or investigations. This was in line with the latest consensus recommendation that initiation of food or feeding should be within 24–48 h or within 72 h.[33,34] Later, the calorie and protein intake became fluctuated due to limiting factors aforementioned and it took time to increase the intake again. Calorie intake achieved a minimum of 80% during day 5 as recommended,[13,35,36] whereas protein intake though not clearly stated in the major recommendation, achieved 80% at day 6. Pillsbury et al.[36] suggested that protein intake should achieve 1.0–1.5 g/kg body weight/day within the first two weeks of injury. The value was quite low if compared to other recommendations for protein and the duration was too long. Calorie and protein intake seemed to decreased at day 7 and day 8, respectively. However, the data was not valid as only one patient had LOS up to 8 days.

In this study, there was a significant difference in intake between day 1 and discharge day although the intake during discharge day was still below than requirement for both calorie and protein. This suboptimal intake of calories and protein may predispose them to develop malnutrition if no intervention or appropriate MNT is provided. The average intakes within a certain period of time are more precise compared to the individual daily intake because malnutrition does not occur within a day.[37,38] Nonetheless, the patients consumed food with appropriate macronutrient distribution as they consumed mostly hospital food which contains adequate nutrients.

This study also found that there was no effect of age, LOE, BMI class, etiology of TBI and main area of brain injury on calorie and protein intake. Thus, although LOE and BMI class generally have an influential effect on dietary intake, other factors such as procedural, physiological and pathological conditions in TBI may reduce food intake.[39–42] Prior to this study, no published literature has revealed the effect of age, etiology of TBI and the main area of brain injury on

dietary intake. This study, however, revealed that TBI patients had low calorie and protein intakes compared to its requirement regardless of age group, etiology of TBI and the main area of brain injury.

We found some effects of gender on calorie and protein intakes in which male patients showed significantly higher intake compared to females but only on the discharge day. This finding was in line with a previous study of Elmadfa et al.[43] which reported that there was a significant difference in calorie intake between genders whereby males had higher calorie and protein intakes than females due to differences in body composition. Males with higher muscle and bone mass thus have higher calorie and protein requirements compared to female.[43] On contrary, Allard et al.[44] found that there were no significant differences in the calorie and protein intakes between males and females as head trauma affected the functional and nutritional status of both genders which resulted in a decrease of both intakes.

Besides we also discovered that TBI severity has an effect on average calorie and protein intakes, i.e. moderate TBI consumed lower calorie and protein. The finding was consistent with the previous study that showed calorie and protein intake were negatively affected by the severity of trauma[45] as dysphagia and some cognitive issues that related dysphagia managements were more common on severer TBI.[15,46–48]

TBI patients who consumed inadequate calorie and protein require appropriate MNT to prevent malnutrition during hospitalization or after hospital discharge. The patient should be recommended or prescribed with additional calorie and protein sources either by oral or enteral feeding through the provision of suitable oral nutrition supplementation. A study has shown that patients with TBI have the potential benefit from enteral nutrition.[49] Previous research also discovered that collaborative efforts could improve patients'outcomes and reduce costs, whilst many professional and regulatory bodies may encourage interdisciplinary approach.[50–52]

Although the intakes of calorie and protein improved by days, TBI hospitalized patients were at a risk to develop malnutrition due to inadequate calorie and protein intakes related to various limiting factors. Overall, calorie and protein intake achieved less than 50% of their requirements. Further follow-up studies are warranted to observe the progression and pattern of nutritional status among TBI patients.

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Ethical Statement

The ethical clearance was granted by the Malaysian Research and Ethics Committee, Ministry of Health Malaysia [NMMR-16-1925-32387].

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Declaration of Competing Interest

The authors declare that they have no conflicts of interest.

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