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Original Article

Enteral Nutrition Feeding Adequacy among Mechanically Ventilated Critically Ill Patients with High Nutrition Risk in a selected Public Hospital in Malaysia : A preliminary study

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Abstract

Background : *Critically Ill patients with high nutrition risk require optimal amount of nutrition therapy for a better clinical outcome.*

Objective : *The objective of this study was to study EN feeding adequacy among mechanically ventilated critically ill patient with high nutrition risk.*

Method : *A prospective observational study was carried out at General Intensive Care Unit (ICU), Hospital Serdang. Adult patients (≥ 18 years old) who were intubated and mechanically ventilated within 48 hours of ICU admission, stayed in ICU for ≥ 72 hours and exclusively fed with EN were included. Eligible patients were followed in ICU for a maximum of 12 days or until death or discharge from ICU. High nutrition risk is determined by a validated nutrition risk screening tool -- the Modified Nutrition Risk in the Critically Ill (NUTRIC) score of ≥ 6.*

Results : *A total of 25 patients were sampled. Mean age was 53 ± 17 years and mean BMI was 26.3 ± 5.3 kg/m*^{2}*. Median time of EN initiation since ICU admission was 8 (Interquartile range [IQR] 3.5-17.5) hours. Among 17 (68%) patients with high nutrition risk, 15 (88.2%) did not receive the recommended optimal nutrition requirement (≥ 80% of calculated energy and protein requirement), despite the fact that the overall energy and protein adequacy was 71.8 ± 14.8% and 62.4 ± 15.1%, performing better than the international average of 61.2 ± 29.4% and 57.6% ± 29.6%, respectively.*

Conclusion : *EN feeding adequacy was suboptimal among critically ill patients with high nutrition risk, as evidenced by 88.2% of high nutrition risk patients not receiving the recommended energy and protein requirement. Identification of patients with high nutrition risk is important to optimize nutrition intake in patients most likely to benefit from optimal amounts of nutrition therapy.*

Keywords : *Nutritional Support; Enteral Nutrition; Critical Illness; Nutrition Risk*

We have no conflict of interest to declare.

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Introduction :

The catabolic state during critical illness necessitates critically ill patients to obtain optimal nutritional support[1]. Large international studies had shown that providing at least 80% of energy and protein target is associated with improved clinical outcomes.[2,3] However, the International Nutrition Survey 2013 revealed that the prevalence of iatrogenic underfeeding (patients receiving less than 80% of energy and protein requirement) worldwide was 74%.[4] The Nutrition Risk in the Critically Ill (NUTRIC) score has been developed and validated specifically among critically ill patients to identify those who will be harmed the most by iatrogenic (hospital-acquired) malnutrition.[5,6]

While nutrition can be provided through the enteral or parenteral route, the provision of nutrition into the gastrointestinal tract, i.e. EN was shown to be superior over parenteral nutrition (PN). This is because EN maintains gut functional and structural integrity, attenuates stress and inflammatory response, and modules metabolic responses in critical illness.[1] EN provided within 24 hours of achieving hemodynamic stability has been shown to improve mortality significantly in various meta-analyses.[7–9] Although EN is associated with feeding intolerance, such as high gastric residual volume (GRV) and/or gastrointestinal symptoms (regurgitation, vomiting and diarrhoea), and may lead to adverse outcome[10], but given the mortality benefits of EN,[7–9] it is recommended in various guidelines.[11–13]

No study had been carried out in Malaysia on EN feeding adequacy among mechanically ventilated critically ill patients with high nutrition risk. Therefore, the objective of this study

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is to fill this gap in order to reveal whether our high nutrition risk patients are being fed optimally.

Methods :

This was a prospective observational study carried out in a mixed medical-surgical ICU, Hospital Serdang, Malaysia.

Adult patients (≥ 18 years old) who were mechanically ventilated within 48 hours of ICU admission and stayed in ICU for ≥ 72 hours were included. This eligibility criteria is consistent with the International Nutrition Survey (INS) conducted by the Clinical Evaluation Research Unit in Canada.[14] This is to enable our results to be comparable to the international data. However, for the purpose of this study, patients who were fed with PN at any day of the study period were excluded.

Daily nutrition data was collected in the ICU until patients were discharged from the ICU, death, or for a maximum of 12 days. Energy adequacy was calculated by dividing energy intake from EN, dextrose and propofol with energy requirement, and protein adequacy was calculated by dividing protein intake from EN with protein requirement. The minimum energy and protein target at which the intake was compared against were 25 kcal/kg and 1.2 g protein/kg body weight, respectively[11,12]. The body weight used was either actual body weight for patients with normal body mass index (BMI 18.5-24.9), ideal body weight at BMI 22.5 for overweight patients (BMI 25-29.9) or adjusted body weight for underweight (BMI < 18.5) or obese patients (BMI ≥ 30)[15].

The formulae for ideal body weight is:

$$Ideal\ body\ weight\ (kg) = (Height\ in\ cm)^2 \times BMI\ at\ 22.5\ kg\ m^{-2}$$

The formulae for adjusted body weight is:

$$Adjusted\ body\ weight\ (kg) = Ideal\ body\ weight + 0.25\ (actual\ body\ weight - ideal\ body\ weight)$$

Acute Physiologic and Chronic Health Evaluation II (APACHE II) and Sequential Organ Failure Assessment (SOFA) scoring system were used to evaluate patients' severity of disease and degree of organ dysfunction. APACHE II is a disease severity classification system, with score range from 0-71 and higher scores indicate higher risk of mortality[16]; while SOFA describe the degree of organ dysfunction, with score range from 0-24 and higher scores indicate higher degree of organ dysfunction[17].

The modified-NUTRIC score was used to access the nutrition risk for each patient admitted to the ICU (Table 1). NUTRIC score is a simple and validated nutrition screening tool developed specifically for critically ill patients.[5] The initial NUTRIC score was modified to remove interleukin-6 (which is not a routine test in ICU) from the variable list and re-validated[6]. The final variables included for the modified NUTRIC score were age, APACHE II score, SOFA score, number of co-morbidities and days from hospital to ICU admission. These variables are relatively easy to obtain and more objective as compared to the traditional nutrition screening variables such as % of weight loss or BMI.[18] High nutrition risk is defined as NUTRIC score ≥ 6.

Data analysis was generated from descriptive statistics. Normally distributed data were presented in mean and standard deviation (mean ± SD) while skewed data were presented in median and interquartile range [median (Q1-Q3)]. SPSS version 22 was used for data analysis.

This study was approved by the Clinical and Research Centre at Hospital Serdang and the Malaysian Research Ethical Committee (NMRR-14-1600-23639).

Results :

A total of 101 patients were screened and 40 (39.6%) were eligible based on the INS inclusion criteria. Among the 40 patients, 25 (62.5%) patients who were not fed with PN (i.e. exclusively fed with EN) were selected for analysis. Total number of evaluable nutrition days in ICU was 270 days, average days of observation were 10.8 days per patient. The average age was 53 ± 17 years old, and 12 (48%) were males. Among ethnic groups, 15 (60%) were Malay, 4 (16%) were Chinese, 3 (12%) were Indians, and 3 (12%) were other races. The mean body mass index (BMI) was 26.3 ± 5.3 kg/m^2.

There were 24 (96%) medical and 1 (4%) surgical patients. The mean APACHE II score and SOFA score was 28.4 ± 8.1 and 11.9 ± 3.2 respectively. The primary diagnosis for ICU admission were mainly due to sepsis 9 (36.0%) and respiratory compromise 6 (24.0%). The 60-day mortality were 36.0% in ICU and 60.0% in hospital (Table 2).

Table 1: The modified-NUTRIC Score (NUTrition Risk in the Critically ill)

Variable	Range	Points
Age (years)	<50	0
	50 – 74	1
	≥ 75	2
APACHE II	<15	0
	15 – 19	1
	20 – 28	2
	≥ 28	3
SOFA	<6	0
	6 – 9	1
	≥ 10	2
Number of Co-morbidities	0 – 1	0
	≥ 2	1
Days from hospital to ICU admission	0 - < 1	0
	≥ 1	1

High Nutrition Risk: NUTRIC score ≥ 6[5,6]

The median time of EN initiation was 8.0 (3.5-17.5) hours. The mean energy and protein adequacy were 71.8 ± 14.8% and 62.4 ± 15.1%, respectively. 18 (72%) of patients received

Table 2: Baseline Characteristics of Patients

BASELINE CHARACTERISTICS	N=25
Age, years	
• Mean (SD)	53 (17)
Sex, Male	
• n (%)	12 (48.0)
Race, n (%)	
• Malay	15 (60.0)
• Chinese	4 (16.0)
• Indian	3 (12.0)
• Others	3 (12.0)
BMI, kg/m²	
• mean (SD)	26.3 (5.3)
Admission Category, n (%)	
• Medical	24 (96.0)
• Emergency Surgery	1 (4.0)
ICU Admission Diagnosis, n (%)	
• Sepsis	9 (36.0)
• Respiratory	6 (24.0)
• Gastrointestinal	3 (12.0)
• Neurologic	3 (12.0)
• Trauma	3 (12.0)
• Hematologic	1 (4.0)
APACHE II Score	
• mean (SD)	28.4 (8.1)
SOFA Score	
• mean (SD)	11.9 (3.2)
NUTRIC Score (%)	
• ≥ 6 (high risk)	17 (68)
• < 6 (low risk)	8 (32)
60-day mortality (%)	
• In ICU	9 (36.0)
• In Hospital	15 (60.0)

<80% of target energy requirement while 23 (92%) received <80% of target protein requirement. About 17 (68%) of the patients had NUTRIC score ≥ 6 and 8 (32%) had NUTRIC score <6. Among patients with high nutrition risk (n=17), the average energy and protein adequacy were only 67.9% and 60.3%, respectively. 15 (88.2%) of high nutrition risk patients received <80% of energy and protein (Table 3).

Table 3: Nutritional Outcome of Patients

NUTRITIONAL OUTCOME	N=25
Time to initiate EN from ICU admission,	
• Median Hour (IQR)	8.0 (3.5-17.5)
Nutrition Received	
• Adequacy of energy (%)	71.8% (14.8%)
• Adequacy of protein (%)	62.4% (15.1%)
• Number received Inadequate Energy (<80% of target)	18 (72.0%)
• Number received Inadequate Protein (<80% of target)	23 (92.0%)
Among patients with high nutrition risk (n=17),	
• Adequacy of energy (%)	67.9% (14.1%)
• Adequacy of protein (%)	60.3% (16.9%)
• Number received Inadequate Energy (<80% of target)	15 (88.2%)
• Number received Inadequate Protein (<80% of target)	15 (88.2%)

Discussion :

This study revealed that 88.2% of our patients with high nutrition risk were not fed adequately despite the fact that our nutrition performance (EN initiation time and overall nutrition adequacy) was better than the international average performance. The median time taken for EN initiation in our center was 8 hours, performing much better than the 38.8 hours reported in the INS 2013. [4] In addition, our mean energy and protein adequacy also outperformed the international average of 60.0% ± 28.3% and 56.7 ± 28.6%, respectively.[4] However, when the patients were divided into high and low nutrition risk based on the NUTRIC score, it was found that our high nutrition risk patients were more iatrogenically underfed as compared with the patients in the INS 2013. [4]

The lesson learned from this finding is that it is imperative to identify patients with high nutrition risk as soon as they are admitted into the ICU. The problem of low EN feeding adequacy for patients with high NUTRIC score cannot be ignored. It was shown that for every unit increase in NUTRIC score, the odds of 28-day mortality were 1.4 times higher. Increased feeding adequacy was associated with increased survival in patients with NUTRIC scores ≥6.[6] However, this does not mean that only high nutrition risk patients should be singled out for aggressive nutritional therapy. Ideally, feeding adequacy should be ensured in all ICU patients in order to strive for the best clinical[2,3] and functional outcome[19]

EN feeding inadequacy among mechanically ventilated critically ill patients is highly prevalent across the globe.[4] The primary reasons was mainly due to frequent interruption of EN feeding. Various common reasons for EN feeding interruption has been reported namely planned procedures (extubation, bedside or radiology suite procedures), gastrointestinal intolerance (high GRV, diarrhoea or vomiting), loss of enteral access and hemodynamic instability.[20–23] Our centre has the same experience, whereby feeding was interrupted mostly due to planned procedures (data not shown). It was shown that interrupted EN feeding lead to 3-folds increased risk of patients being underfed, and 26% of EN feeding interruptions were avoidable.[24] Novel EN protocol such as the PEP uP protocol was shown to improve EN feeding adequacy significantly[25] and therefore it is recommended to adopt this protocol into the local setting.

A single-centre study in an ICU of a University Hospital in Malaysia with multidisciplinary team in feeding management had 66% of their patients achieved 80% of caloric requirements within 3 days of ICU admission[26], while only 44% of patients in our ICU achieved 80% of caloric requirements within the same period. One of the reasons for the poorer performance in our centre might be due to the absent of a full time (resident) dietitian who is well versed in the feeding management of the critically ill patient. It has been shown that an ICU with an attending dietitian will tend to have a better feeding adequacy[27].

A few points about our results warrant further discussion. Although minimum protein requirement of 1.2 g/kg body weight was used to calculate percentage of protein adequacy, it must be emphasized that this amount may not be adequate. It is important to note that critically ill patients require more proteins especially those experienced polytrauma, severe sepsis and acute kidney injury receiving regular renal replacement therapy[11]. Even with this low level of protein target, our patient only received approximately 62.4% of this target, with the average of approximately 0.75g/kg body weight. This level is dangerously low given the facts that there were a strong association of protein intake and clinical outcomes among critically ill patients[3,28].

Our ICU patient population were skewed toward the medical side because of several reasons. Firstly, the system in this hospital where the study were conducted admitted the relatively "well" surgical patients to the Post Anaesthesia Care Unit (PACU) rather than the ICU after surgery. Patients are admitted then to the general ward once they are extubated and stabilized. Whereas the more "ill" surgical patients who are not able to be discharged to the wards from PACU within 24-48 hours post-op will be admitted to the ICU. These patients are likely to be hemodynamically unstable, had complex surgical procedures and therefore would more likely be receiving PN. While medical patients are generally easier to feed, they tend to have worse mortality outcomes as compared to surgical patients due to higher number of co-morbidities. This is also shown by the high APACHE II score recorded (28.4 ± 8.1), as compared with 22.4 ± 9.0 in the INS 2013 population. These might explain the reason for the high crude in-ICU and in-hospital mortality rate found in this study (36.0% and 60.0%, respectively) as compared to the national in-ICU and in-hospital mortality rates (19.9% and 26.7%, respectively)[29].

The limitation of this study must be considered when generalization of the finding is made. The sample size is relatively small considering the preliminary analysis that we made. In addition, this result is only limited to one public tertiary hospital and may not represent the overall situation of the country. However, it is important to note that patients were followed-up for a total number of 270 days. Nonetheless, this result had provided us a glimpse of enteral feeding adequacy among high nutrition risk patients in a Malaysian public tertiary hospital without a full time dietitian.

No further analytical statistical testing was done to evaluate the relationship between energy and protein adequacy and clinical outcomes (i.e. mortality) given the low sample size. We are not sure whether the high mortality rate is related to the feeding inadequacy or disease severity without using the more advanced statistical testing. Given that 88.2% of our high nutrition risk patients were underfed, it is plausible that both feeding inadequacy and disease severity are affecting patients' survival. Many large multi-centre research had been done and confirmed the relationship between feeding adequacy and clinical outcomes after adjusting for disease severity status[2,3,19], especially in patients with high nutrition risk[6] A Malaysian cohort study on nutritional support practices in ICU is eagerly awaited.

Conclusion :

In a single-centre study, optimal enteral feeding adequacy was not achieved in 88.2% of mechanically ventilated critically ill patients with high nutrition risk, as identified by the modified-NUTRIC score of 6 and above. It is recommended to screen all ICU patients to identify those with high nutrition risk. However, effort should be made to provide optimal nutrition for all critically ill patients in order to improve overall clinical and functional outcome. A larger study in multiple ICU across the country is needed to provide better information and perspective into this topic.

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