ORIGINAL ARTICLE

An Observational Study of Nutritional Assessment, Prescription, Practices, and Its Outcome among Critically Ill Patients Admitted to an Intensive Care Unit

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Abstract

Aim and background: Optimal feeding strategy for critically ill patients of intensive care unit (ICU) is often a matter of debate as patients admitted to ICU are highly catabolic and reduction in muscle mass is very common. We aimed at early achievement of nutritional goals in preventing skeletal muscle breakdown and improving clinical outcomes among critically ill patients with high risk of malnutrition.

Materials and methods: Nutrition risk in the critically ill (mNUTRIC) Score was used to identify the risk of malnutrition within 24 hours of admission. Quadriceps muscle mass index was measured within 24 hours of admission to ICU and repeated on 7th day. Enteral feeding was monitored by the nutrition expert as part of routine patient care and clinical outcomes were monitored.

Results: A total of 287 patients admitted in ICU were screened for malnutrition and 60 (20.9%) of them had high score (>5). There was no statistically significant reduction in the quadriceps muscle mass index ($p < 0.05$) ($t = 0.601$) measured within 24 hours of admission and on the 7th day of ICU stay, signifying that the nutritional prescription and monitoring may be useful in preserving the muscle mass. This study did not find statistically significant association between the high mNUTRIC score on admission and the clinical outcomes, such as 28 days mortality, incidence of pressure ulcers, length of ICU stay, and hospital-acquired infection ($p > 0.05$).

Conclusion: Early initiation and maintenance of enteral nutrition is essential for meeting target calories and protein requirements. It may help to preserve muscle mass in critically ill patients who are otherwise at high risk of malnutrition.

Keywords: Clinical outcomes, Critically ill patients, Intensive care units, mNUTRIC score, Malnutrition, Observational study Quadriceps muscle mass, Quadriceps muscle mass index, Ultrasound.

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Highlights

- Addressing the debate over optimal feeding strategies for critically ill intensive care unit (ICU) patients, early achievement of nutritional goals was investigated to prevent skeletal muscle breakdown.
- Nutritional prescription and monitoring, particularly through the mNUTRIC Score, may be effective in preserving quadriceps muscle mass, emphasizing the importance of timely intervention.

Introduction

Malnutrition affects 20–50% of hospital patients.[1] There is evidence to support the link between ICU-acquired malnutrition and poorer patient outcomes. Malnutrition is a substantial predictive risk factor for critically ill patients, influencing important outcomes like mortality, length of stay (LOS), time spent on mechanical ventilation, and infection rates.[2] The optimal dietary support is crucial for obtaining successful clinical results when managing a critical illness.[3] Continuous screening and assessment of nutrition is vital for all hospitalized critically ill patients to enable early intervention with essential protein and energy supplementation.[4]

The advantages of proper nutrition in critically ill patients include a minimal risk of hospital-acquired infections, such as wound infections, pressure ulcers, loss of skeletal muscle mass, a shorter duration of mechanical ventilation, a shorter stay in the ICU and reduced hospitalization along with lower mortality rate. There is a lack of reliable information regarding the advantages of adequate nutrition or the risks of inadequate nutrition in critically ill patients.[5] The patients with a greater lack of muscle mass spent more time in the ICU[6] and despite the seriousness of the disease, muscle mass is found to be a protective factor against mortality.[7]

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In the ICU, early dietary assessment, diagnosis, and management of malnutrition may reduce the likelihood and severity of illness and mortality. Nutrition risk in critically ill (mNUTRIC) scale can be used on admission, as a bedside nutritional evaluation method that can identify critically sick individuals at high risk of malnutrition and who could benefit from aggressive nutritional therapy. Assessing the high nutritional risk with mNUTRIC score along with other investigations can be a real benefit for the ICU patients.[8]

According to critical care nutritional recommendations, 0.8–1.2 gm/kg proteins per day is given in mild-moderate illness and 1.2–1.5 gm/kg protein per day is recommended in critically ill patients. The protein requirements increase as the illness becomes more severe.[9] An observational study among critically ill found that better survival is associated if protein and other nutritional demands are met. It also reduces the ventilator support days, as well as shortens time to get discharged alive from the ICU.[10] The optimal caloric goal among critically ill adult patients is calculated through simplistic formulas (25–30 kcal/kg/day). However, researcher consensus on the best energy target for critically ill patients is still lacking.[3] The preferred use of enteral nutrition (EN) with in the first 24–48 hours of admission to ICU is consistently advised by the most recent international nutrition standards in cases where patients are critically ill and unable to maintain adequate oral intake.[9,11]

When compared with the international settings, critical care settings and practices in India are completely different.[12] Direct use of EN guidance is available globally, but there are no clear nutritional recommendations for Indian critical care settings to address challenges in the region. As a result, early identification of nutritional needs and enteral feeding activities will help patients' nutritional status and outcomes.[7] Nutrition is now recognized as having therapeutic value, rather than being merely supplemental or supportive, in enhancing patient outcomes. In the case of the majority of ICU patients, it is advisable to prioritize standardized formula feeds as a scientifically based nutritional option, as opposed to utilizing blenderized feeds.[12] In the literature, Indian studies on monitoring and achieving prescribed kilocalories and proteins, the nutritional impact on mortality and morbidity among critically ill patients is very limited. Despite adhering to recommendations and feeding protocols, a significant disparity persists between the prescribed nutrition and the actual calories and proteins administered to critically ill patients on mechanical ventilation in ICU. Airway-related procedures and GI intolerance are few of the most common causes of withholding the feeds in ICU setting.[13]

Thus, our study hypothesized to see favorable effects of early achievement of nutritional goals on preservation of skeletal muscle mass and clinical outcomes of ICU patients who are at high risk of malnutrition on admission.

Materials and Methods

A descriptive observational study was conducted among the critically ill patients receiving treatment in the multidisciplinary ICU of a tertiary care hospital of South India. We have included the patients admitted in ICU aged 18 years and above, on enteral feeding and with high mNUTRIC score in the study. Patients with lower limb amputation were excluded as the muscular ultrasound was not possible. Sample size for the study was decided on G power 3.1.9.7, using input and output parameters, the actual power was 0.9015466. Thus, the sample size calculated was 49, additionally considering LOS, 15% extra added, thus, the sample size was decided to be 60 for the study. Total of 287 patients screened with mNUTRIC score, out of which 60 (20.9%) were with high mNUTRIC score. The data were collected between 2nd March and 25th May 2022 by using demographic proforma to collect the baseline data and critical care daily monitoring EN checklist to assess the days on which the targeted kilocalories and proteins are achieved. The measurement of the right and left quadriceps muscle mass index was measured using ultrasound machine within 24 hours of patient admission to ICU. Follow-up muscle mass index was planned on 7th, 14th, 21st, and 28th day for the patients remaining in ICU. Left and right quadriceps muscle measurements with and without muscular compression was taken and mean measurement of both the lower limbs was considered as Quadriceps muscle mass index score. Bland–Altman plot was computed to assess the reliability of USG and the tool was reliable (mean difference was −0.0606 and $p = 0.144$; $r = 0.733$). The practice and delivery of the feeds was monitored by the nutrition experts as part of routine patient care for achieving targets of prescribed kilocalories and proteins. Clinical outcome variable checklist was used to monitor for 28-day mortality/morbidity, occurrence of pressure ulcers, length of ICU stay and occurrence of hospital-acquired infection.

Table 1: Distribution of the sample based on demographic characteristics *N = 60*

Demographic characteristics	*Frequency (f)*	*Percentage (%)*
Age in years		
20–40	07	11.7
41–60	15	25.0
61–80	34	56.6
81 and above	04	6.7
Gender		
Male	39	65.0
Female	21	35.0
Comorbid illness		
Yes	60	100
No	00	00
Type of diet		
Vegetarian	12	20.0
Non-vegetarian	48	80.0

Ethical Considerations

Study was approved from Institutional Ethics Committee (IEC 621/2021). Written informed consent was taken prior to enrolling into the study. Study was registered with the clinical trial Registry of India (CTRI/2022/01/039698) to ensure the transparency and enhance the visibility.

Statistical Methods

The data collected were coded and analyzed using SPSS 16.0. Descriptive statistics (frequency and percentage) were computed to describe the demographic variables, prescribed and achieved energy and proteins, and the occurrence of outcome variables. Paired samples "*t*" test was computed to analyze significant difference of muscle mass index on day 1 to 7th day. The association between clinical outcome variables and mNUTRIC was analyzed through Chi-square (χ^2) test.

Results

Among the 60 patients enrolled in the study, 53 (88.3%) were aged 41 years and above (Table 1). All of them had existing comorbidities.

Mostly about 32 (53.3%) of them had the mNUTRIC score of 5, 16 (26.6%) had score of 6, seven (11.7%) had score of seven and another four and one had score of 8 and 9, respectively. The targeted energy was between 1001 and 2000 kilocalories, and majority about 44 (73.3%) of the participants achieved the prescribed kilocalories of 1001–1500. Findings showed 2 (3.3%) of them did not achieve targeted kilocalories (Table 2). Only 34 (56.7%) and 40 (46.7%) of them achieved prescribed kilocalories and proteins respectively by day 5. Meanwhile, 11 (18.3%) of the participants were not able to achieve prescribed kilocalories and proteins before 8 days due to death (Table 3).

Statistical paired "*t*" computed for the quadriceps muscle mass index showed that the mean ± SD on 1st day and 7th day was 1.46610 ± 0.521259 and 1.53600 ± 0.525855, respectively, and this difference was not statistically significant ($p < 0.05$) ($t = 0.601$). Thus, it is inferred that the nutritional monitoring and prescription may be useful in preserving the muscle mass since there was no statistically significant reduction in quadriceps muscle mass index (Table 4).

Table 2: Frequency (f) and percentage (%) of participants on targeted and achieved kilocalories and proteins *N = 60*

	Target		*Achieved*	
Variables	*Frequency (f)*	*Percentage (%)*	*Frequency (f)*	*Percentage (%)*
Kilocalories				
500–1000	–	–	02	3.3
1001–1500	24	40.0	44	73.3
1501–2000	36	60.0	13	21.7
2001–2500	–	–	01	1.7
Proteins				
0–50 gms	23	38.3	26	43.3
51–100 gms	37	61.7	34	56.7

Table 3: Frequency (f) and percentage (%) of participants on days of achieving targeted kilocalories and proteins

	Kilocalories		*Proteins*	
Days of achieved	*Frequency (f)*	*Percentage (%)*	*Frequency (f)*	*Percentage (%)*
Day 1	00	00	02	3.3
Day 2	07	11.7	07	11.7
Day 3	04	6.7	05	8.3
Day 4	13	21.6	14	23.4
Day 5	10	16.7	12	20.0
Day 6	04	6.7	03	5.0
Day 7	02	3.3	00	00
Day 8 and above	09	15.0	06	10.0
Unable to achieve (Death)	11	18.3	11	18.3

Outcome measures variable showed that 26 (43.3%) mortality within 28 days, 19 (31.7%) developed healthcare-acquired pressure ulcers. Hospital-acquired infections was found among 29 (48.3%) during the entire hospital stay. Chi-square was computed to find the association between mNUTRIC score and the clinical outcomes variables. Findings showed that there was no significant association between mNUTRIC score and any of the clinical outcomes' variables ($p > 0.05$) (Table 5).

Discussion

The prevalence and percentage of malnutrition is greatly varied among critically ill patients. In our study we found that about 21% of admitted patients in ICU were at high risk of malnutrition and high mortality. In acute care settings, 30–50% of hospitalized patients suffer from malnutrition.[14–16] Prevalence of malnutrition in hospitalized critically ill patients at Egypt showed that 50% patients were malnourished with the severity varying from mild-to-moderate of 35.3% to severe was 14.7%.[17] Existing literature and reviews also support that the critical care patients have multiple of comorbidities, along with their primary acute disease.[18] Patients who are critically ill are a highly diverse group and frequently have a variety of comorbid conditions.[19]

Our study included patients with high mNUTRIC score >5 to know their demographic profile and associated comorbid illness. This subgroup is expected to have high mortality and risk of malnutrition which may result in loss of muscle mass, more incidence of hospital-acquired infections, pressure ulcers and are expected to stay longer on ventilator and in ICU. In our study, 73% of the patients were able to achieve energy requirement and 66% of them were able to achieve protein requirement of about 1.5 gms within day 5. However, by day 7, almost all of them had met their goals, who were at high risk. Findings of a pilot study by Yamamoto S et al., on meeting the protein and caloric requirements of critically ill patients also supported the findings of the current study. During the first 3 days, 78.9 and 73.7% of the subjects, respectively, met their protein and calorie requirements to at least 50%.[20]

The study population was at high risk of malnutrition and were expected to have loss of muscle mass during the stay of ICU due to critical illness, and this was measured by taking the ultrasound of quadriceps muscle. But they did not have significant muscle mass loss at the end of day 7 ($p < 0.05$) ($t = 0.601$). This could be due to nutritional monitoring and achieving energy and protein targets in majority of these patients before the 7th day of ICU stay.

Study findings showed that the healthcare-acquired pressure ulcer occurred among 19 (31.7%), 26 (43.3%) had mortality within 28 days, and hospital-acquired infections were noted among 29 (48.3%) of the participants. Further, there is no significant association between the mNUTRIC score and pressure ulcer ($p > 0.05$), as malnutrition is one of the very important risk factors.[21] In order to prevent morbidity and mortality in critically ill patients, the right amount of protein and energy must be provided. A daily increase of 1,000 calories was linked to lower mortality ($p = 0.014$) and an

Table 4: Paired "*t*"-test on quadriceps muscle mass index at two different time points among the participants *N = 60*

Quadriceps muscle mass index	*Mean*	*+SD*	*Mean difference*	*95% CI*		*t*	*df*	*p-value*
				*LL**	*UL**			
Day 1 ($n = 60$)	1.46610	0.521259						
Day 7 ($n = 20$)	1.53600	0.525855	–0.699	–0.3452	0.2054	–0.531	19	0.601

*Lower limit and Upper limit

Table 5: Chi-square (χ^2) between mNUTRIC score and outcome variables of the participants *N = 60*

	mNUTRIC score				
Outcome variables	*5–6*	*7–9*	*χ^2 value*	*df*	*p-value*
Occurrence of healthcare-acquired pressure ulcers					
Yes	16	03	0.735	1	0.428
No	32	09			
28 days mortality					
Yes	20	06	0.271	1	0.602
No	28	06			
Length of ICU stay					
1–15 days	46	11	0.495	1	0.495
15 days and more	02	01			
Number of hospital-acquired infection					
Occurred	25	04	0.337	1	0.201
Not occurred	23	08			

increase in the number of ventilator free days (p = 0.003). Thus, in critically ill patients, higher calorie and protein intakes seem to be linked to better clinical outcomes.[22] However, there is research findings stating greater caloric (25 kilocalories) as well as proteins (1.2 gm/kg) intake not related to lower 28-day mortality rate in individuals with low nutritional risk. Lower 28 day mortality rates were linked with increased caloric intake of 25 kcal/kg,[23] which takes call for further research to strengthen the evidence. In our study, gram-negative organism, such as *E-coli* and *Pseudomonas* was grown among 28 (96.5%) of all the hospital-acquired infections. Gram-negative bacteria are more frequently responsible for nosocomial infections, particularly infections acquired in ICUs and these infections are linked to longer mechanical ventilation days and longer ICU stays.[24] Thus, malnutrition, inflammation, acquired infections and LOS in the hospital is interrelated.

The positive findings of our study are that early initiation and maintenance of EN has probably positive impact on maintaining the quadriceps muscle mass index and preservation of skeletal muscle mass could have a very favorable impact on ICU outcomes. However, this cannot be directly concluded as the reasons could be multifactorial. The study was conducted in a single group of patients and within stipulated time period. But we had included a very important cohort of ICU patients who were at high risk of malnutrition and majority of these patients were able to achieve their nutritional goals by days 5–7 which was a reflection of quality of nutritional prescription and monitoring. Our study also could not observe any association of early achievement of nutritional goals and clinical outcomes. Further studies in this regard are needed to consolidate this important observation.

Ultrasound monitoring of skeletal mass index was done for most of our patients for the first 1 week, and it was done by the nurse practitioners in critical care under supervision which was very innovative. However, it was possible only for 20 patients beyond 7th day and for another two on day 14 as many of our patients were shifted out from ICU and shifting the USG machine out of ICU was not possible due to ethical reasons and hospital policy of on use of ICU USG machines outside ICU premises. Further research needs to be conducted in larger patient groups with longer follow-ups to address these issues in a better way.

This study can be a starting point for future research of very specific group of ICU patients who are at high risk of malnutrition and expected to have adverse outcomes, unless there is timely nutritional intervention which is important but often forgotten during ICU rounds. It is a simple but very effective intervention if all members of ICU team focus and play their roles in achieving goals of nutrition at the earliest possible time. Ultrasound of skeletal muscle is a very objective tool in monitoring muscle mass and can be effectively utilized in future studies on nutritional monitoring of ICU patients.

Conclusion

Early nutritional prescription, continuous monitoring and achieving the goals of protein and energy targets can help in preserving the skeletal muscle mass of the critically ill patients during the early weeks of the ICU stay. However, its benefits on clinical outcomes, such as 28 days mortality, occurrence of healthcare-acquired pressure ulcers, LOS in ICUs, and number of hospitals-acquired infection is not statistically significant.

Clinical Significance

Early initiation and careful maintenance of EN demonstrate the impact in preserving quadriceps muscle mass among critically ill ICU patients, suggesting a valuable approach to mitigating the common challenges of catabolism and muscle mass reduction in this high-risk population.

Authors' Contribution

All authors contributed to the study conception and design. Material Preparation was done by Teena Sharon, Shalini Ganesh Nayak, Vishal Shanbhag, and Suvarna Hebbar. Data were collected by Teena Sharon and supervised by Vishal Shanbhag. Nutritional status was monitored by Teena Sharon and Suvarna Hebbar. Data analysis was done by Teena Sharon and Shalini Ganesh Nayak. The first draft of manuscript was written by Teena Sharon and Shalini Ganesh Nayak and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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