Factors Associated with Malnutrition among Critically Ill Stroke Patients

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Abstract

Background: *Malnutrition is a significant concern among critically ill stroke patients, impacting recovery, survival, and healthcare burden. Identifying the factors' influencing malnutrition is essential for developing targeted interventions, with critical care nurses that playing a key role in nutritional assessment, monitoring, and ensuring adequate enteral nutrition. The prevalence of malnutrition after acute stroke varies widely, ranging from 6.1% to 62%, with studies indicating that up to 32% of patients are malnourished within six days of stroke onset.* ***Objective:*** *To determine the factors associated with malnutrition among critically ill stroke patients.* ***Settings:*** *The study was conducted in two University Hospitals namely: Alexandria Main University Hospital (AMUH) and Smouha University Hospital (SUH), Egypt.* ***Subjects:*** *A purposive sampling of 80 adult critically ill patients, newly admitted within 24 hours of ICU admission, aged 18 - ≤ 60 years, diagnosed with acute stroke and receiving enteral feeding were included in this study. Patients who are excluded: Length of stay less than 7 days. Malnutrition on admission defined by BMI of less than 18.5 kg/m^2. Newly admitted patient with diarrhea or vomiting.* ***Tools:*** *two tools were used. Tool one: "Critically ill patients' assessment record ". Tool two: "Malnutrition among critically ill stroke patient's assessment record ".* ***Results:*** *The study found a significant difference (p<0.001) between required, dispensed, and delivered enteral feeding. About two third of patients 62.5% had moderate malnutrition, while 27.5% had mild malnutrition and 10.0% had severe malnutrition.* ***Conclusion:*** *Malnutrition approximately occurs in all critically ill stroke patients admitted to the ICU and is influenced by patient, staff, and therapeutic management factors. Patient-related factors include age, sex, abdominal distension, hemodynamic instability using vasopressor, and modified nutrition risk in the critically ill (mNUTRIC) score, while staff-related factors involve misinterpretation of gastric residual volumes, fear of adverse events associated with enteral feeding, and delays in enteral nutrition initiation. Therapeutic management factors, such as prolonged enteral nutrition withholding and awaiting procedures, significantly impact caloric and protein intake.* ***Recommendations:*** *Critical care nurses should conduct a thorough assessment, including a comprehensive nutritional assessment for patients with acute stroke. Implementing standardized strategies, including standing orders, bedside protocols, and structured guidelines for tube feed management.*

Keywords:
Critically ill patients, malnutrition, stroke

Introduction

Critically ill patients often experience metabolic alterations and hypercatabolism, which increase their protein and energy needs. Stroke patients, in particular, face multiple interconnected factors affecting their nutritional status, including dysphagia, neurological deficits, impaired cognition, and systemic inflammation. These factors elevate the risk of malnutrition, which significantly impacts their recovery and prognosis (Chen et al., 2023; Hsu et al., 2021).

Stroke remains the second leading cause of death worldwide and the third leading cause of death and disability combined. It affects approximately 15 million people annually, with 5 million dying and another 5 million experiencing permanent disability. In Egypt, stroke prevalence is notably high, with a crude rate of 963 per 100,000 inhabitants, placing a significant burden on families and healthcare systems (Nasreldein et al., 2024; WHO, 2021).

Malnutrition is a critical concern in critically ill stroke patients, affecting their recovery and survival. It has been linked to prolonged hospital stays, increased risk of infections, and higher mortality rates. The prevalence of malnutrition after acute stroke varies widely, ranging from 6.1% to 62%, with studies indicating that up to 32% of patients are malnourished within six days of stroke onset (Sguanci et al., 2023; Tang et al., 2022).

Malnutrition in stroke patients results from a combination of physiological, neurological, and psychosocial factors. Dysphagia, impaired motor function, cognitive deficits, and lack of caregiver support contribute to inadequate nutritional intake. Furthermore, stroke-induced metabolic changes, including hypermetabolism and systemic inflammation, heighten nutritional demands that are often unmet (Di Vincenzo et al., 2023; Poomalai et al., 2023).

Ensuring adequate nutrition in critically ill stroke patients is essential. Enteral and parenteral nutrition play a crucial role in maintaining energy balance, particularly for patients requiring prolonged intensive care. Given the severe consequences of malnutrition, identifying its determinants is vital for developing targeted interventions (Shestopalov et al., 2024; Mehta et al., 2022).

Critical care nurses (CCNs) play a vital role as an integral part of the multidisciplinary team in the nutritional management of critically ill stroke patients, they responsible for nutritional assessment, continuous monitoring of nutritional status and ensuring that these patients receive their prescribed nutrition. Furthermore, they calculate the caloric requirements, analyze daily caloric delivery and advocate for adequate enteral nutrition (Junaid et al., 2024; abdelhady et al., 2022).

Aims of the Study

This study aimed to determine the factors associated with malnutrition among critically ill stroke patients.

Research question

What are the factors associated with malnutrition among critically ill stroke patients?

Materials and Method

Materials

Design: A descriptive exploratory research design was used to conduct this study.

Settings: This study was conducted in two University Hospitals namely: Alexandria Main University Hospital (AMUH) and Smouha University Hospital (SUH). General ICUs (unit II, III and triage) at Alexandria Main University Hospital beds capacity is 12, 18 and 8 beds respectively. Stroke ICU at Smouha University Hospital (SUH) beds capacity is 4 beds.

Subjects: A purposive sampling of 80 adult critically ill patients, newly admitted within 24 hours of ICU admission, aged 18 - ≤ 60 years, diagnosed with acute stroke and receiving enteral feeding were included in this study. The sample size was calculated using power analysis (Epi-info7) program based on the following parameters: population size =98/6months, expected Confidence level =95%, Margin of error =5%, Prevalence of the problem =50%, Minimum sample size =78%. Newly admitted patient with diarrhea or vomiting, malnutrition on admission defined by BMI of less than 18.5 kg/m^2, length of stay less than 7 days were excluded from the study.

Tools: In order to collect the necessary data for the study two tools were used:

Tool one: "Critically Ill patients' Assessment Record". It was used to assess critically ill patients. **It consists of three parts:**

Part I: Patients' Demographic and Clinical data: this part was developed by the researcher after reviewing related literature (Shestopalov et al., 2024; Mehta et al., 2022) to assess patients' demographic data such as: age and sex, and clinical data such as date of ICU admission, , type of stroke either ischemic or hemorrhagic, past medical history and treatment implemented medical intervention such as administration of thrombolytic ,anticoagulant, mannitol or hypertonic saline or surgical intervention.

Part II: National Institutes of Health Stroke Scale (NIHSS): It was adopted from Lyden et al., (2009) to assess acute stroke-related neurological deficit and severity. The reliability of this scale was also tested by (Lyden et al., 2009) and it was 0.85. This scale assesses 11 items: level of consciousness, horizontal eye movement, visual field test, facial palsy, motor arm, motor leg, limb ataxia, sensory, language, speech, extinction and inattention. The maximum score is 42 and the minimum score is zero. Zero indicates no stroke symptoms, 1-4; minor stroke, 5-15; moderate stroke, 16-20; moderate to severe stroke, 21-42; severe stroke.

Part III: Modified nutrition risk in the critically ill (mNUTRIC) score: It was adopted from Rahman et al., (2016) to identify patients at risk for malnutrition. The reliability of this scale was tested by (Alramly et al., 2020) and it was 0.87. This scale assesses 5 variables: age, number of co-morbidities, days from hospital to ICU admission, Acute Physiology and Chronic Health Evaluation (APACHE II) score and the Sequential Organ Failure Assessment Score (SOFA) score. The total score is 0 to 9, a score of ≤4 indicates low risk of malnutrition, while a score of 5-9 indicates high risk of malnutrition.

Tool two: "Malnutrition among stroke Critically Ill patient's Assessment Record''. This tool was developed by the researcher after reviewing the related literature (Wang et al., 2023; Compher et al., 2022) to assess the malnutrition among critically ill stroke patients. **It consists of two parts**:

Part I: Nutritional status assessment data: It was used to identify nutritional status assessment data after reviewing the related literature (Di Vincenzo et al., 2023; Sirianansopa et al., 2022). It included anthropometric measurements, body mass index (BMI), head to toe physical examination and biochemical markers such as serum hemoglobin, urea and creatinine.

Part II: Nutritional intervention related data: It was used to identify nutritional intervention related data after reviewing the related literature (Wang et al., 2023; Compher et al., 2022; Ezz El-Regal et al., 2016). It included the time of initiation of enteral feeding (EF) after ICU admission, method of enteral feeding, type, amount and frequency of feeding, size of enteral feeding tube, causes and duration of feeding interruption, complications associated with enteral feeding, actual dietary intake and the total daily energy expenditure (TDEE) of patients.

Method

Approval of the Research Ethics Committee, Faculty of Nursing, Alexandria University was obtained. An official approval to conduct this study was obtained after providing explanation of the aim of the study to the hospital's authorities. Study tool one (part I) and tool two were tested for content validity by five experts in the field of the study. The necessary modifications were done accordingly. A pilot study was carried out on 10% of the study sample in order to test the clarity and applicability of the research tools. The reliability coefficient was 0.74 which is acceptable. Data was collected by the researchers during the period from March 2024 to August 2024.

Patients fulfilling study criteria were included in this study immediately after admission to the previously mentioned ICUs. Patient's demographic and clinical data such as: age, sex, date of ICU admission, type of stroke, past medical history and treatment implemented for stroke management were assessed and recorded for each patient on admission.

The severity of stroke was assessed using National Institute of Health Stroke Scale (NIHSS), the patient's risk for malnutrition was assessed using modified Nutrition Risk in Critically Ill (mNUTRIC) score and recorded on admission.

Anthropometric measurements measured, weight, height and body mass index (BMI) were estimated using validated equations twice on admission and after 7 days. Biochemical markers, a head-to-toe physical examination were assessed twice and recorded on ICU admission and after 7 days for signs of nutritional alteration.

Time of initiation of enteral feeding, causes and duration of feeding interruption were recorded daily for 7 days. The actual dietary intake (calories, protien, total enteral volume) of the patient per day was calculated by researcher and recorded daily for 7 days. These calculations based on Egyptian food composition table (2006).

Total daily energy expenditure (TDEE) was calculated using this equation:

- TDEE (Required) = basal metabolic rate (BMR) x activity factor x stress factor

BMR calculated using Mifflin St. Jeor equation (kcal/ day) as follows:

-Male:10 (wt) + 6.25 (ht) - 5 (age) + 5

-Female:10 (wt) + 6.25 (ht) - 5 (age) - 161

Activity factor: Sedentary (little or no exercise)= 1.2, the stress factor was estimated based on patient's condition.

The difference between required, dispensed and delivered nutrition was analyzed daily and recorded. Delivered / required x 100 was the percentage used to represent the difference. Adequate feeding was meeting 90% of requirements, whereas underfeeding was actual average intake falling below 90% of total requirements; mildly underfed (89%–50%), moderately underfed (49%–30%), and severely underfed (<30%). Overfeeding exceeded 110% of the overall requirements.

The Global Leadership Initiative on Malnutrition (GLIM) criteria were used for diagnosis malnutrition. A dual-component approach, including phenotypic (unintentional loss of weight, BMI or muscle mass) and etiologic (reduced intake, inflammation or disease burden) factors, was applied.

Ethical considerations:

Written informed consent was obtained from each conscious patient and written consent from guardian if unconscious after an explanation of the aim of the study and the right to refuse to participate in the study and/ or withdraw at any time. Patient's privacy was respected. Data confidentiality was assured throughout the study.

Statistical Analysis

Data were fed to the computer and analyzed using Statistical Package for Social Sciences (IBM SPSS/ version 25.0) software, and tabulated (Armonk, NY: IBM Corp). The qualitative data were described using number and percent. To describe the quantitative data, the following attributes were employed: mean, standard deviation, and range (minimum and maximum). Finally, analysis and interpretation of data were conducted. P-values of 0.05 or less were considered statistically significant.

Results

Table 1 Shows the distribution of studied critically ill stroke patients according to their demographic data. According to sex, it can be noted that (52.5%) were females and (47.5%) were males. According to age, about two third of patients (67.5%) were aged (56-60) years. The mean age was 56.2 ± 3.97 years.

Table 2 Shows the distribution of the studied critically ill stroke patients according to the risk for malnutrition based on Modified Nutrition Risk in Critically Ill (mNUTRIC) score on admission. It was found that (72.5%) of the patients had low nutritional risk, while only 27.5% had high nutritional risk.

Table 3 Shows comparison between anthropometric measurements of studied critically ill stroke patients on admission and after 7 days. It was observed that there was a significant decrease ($p<0.001$) in all anthropometric measurements in terms of mid-upper arm circumference (MUAC), triceps skin fold thickness (TSFT), body weight and body mass index (BMI) in the seventh day of ICU admission as compared to first day anthropometric measurements.

Table 4 Shows comparison of the studied critically ill stroke patients regarding signs of malnutrition in the 1st and 7th day. It was observed that there was a significant increase ($p<0.001$) in the majority of signs of malnutrition in term of pale skin, generalized edema, pale conjunctiva, dry skin and dry mouth in the seventh day of ICU admission as compared to first day signs of malnutrition findings.

Table 5 Shows comparison of the studied critically ill stroke patients regarding biochemical values in the 1st and 7th day. It was observed that; there was a significant decrease in hemoglobin (Hb) ($p<0.001$) and serum potassium level ($p<0.05$) in the seventh day of ICU admission as compared to first day biochemical values. While urea, creatinine and sodium were insignificant ($p>0.05$).

Table 6 Compares the required, dispensed, and delivered nutrients (calories, protein, and enteral volume) along seven consecutive days. It was observed that there was a significant difference ($p<0.001$) between required and delivered enteral feeding. Moreover, there was a significant difference ($p<0.001$) between required and dispensed enteral feeding and there was a significant difference ($p<0.001$) between dispensed and delivered enteral feeding.

Table 7 Shows distribution of the studied critically ill stroke patients according to the adequacy of nutrition received. Regarding the calories, 62.5% of the patients were mildly underfed, 35.0% were moderately underfed and 2.5% were severely underfed. Regarding the protein, 67.5% of patients were severely underfed and 32.5% were moderately underfed. Regarding the enteral volume, 88.75% of patients were mildly underfed, 6.25% were moderately underfed and 5.0% were severely underfed.

Table 8 Shows nutritional intervention related data of studied critically ill stroke patients. It was observed that the mean time of initiating EN after ICU admission was 8.08±10.41 hours. The mean number of interruptions in EN during the 7 days was 6.44±2.22. mean duration per one interruption was 5.48±7.03 hours, which represents a mean interruption duration of 29.27±17.41 hours per patient for 7 days.

Figure 1 Shows the distribution of the studied critically ill stroke patients according to the global leadership initiative on malnutrition (GLIM) criteria for the diagnosis of malnutrition after 7 days. It can be noted that most of the of patients were classified as having moderate malnutrition, accounting for (62.5%) of the cohort, while (27.5%) were categorized with mild malnutrition and (10.0%) were diagnosed with severe malnutrition.

Table 9 Presents the relationship between nutritional adequacy and causes of EN withholding, highlighting significant associations. Adequacy of calories and enteral volume associated with abdominal distension (P=0.043, P=0.012), while protein adequacy linked to hypotension, vasopressor use (P=0.043), and therapeutic procedures (P<0.001). Enteral volume adequacy showed associations with vomiting (P=0.002) and unscheduled basic nursing care (P=0.007). Malnutrition demonstrated a significant associated with fear of adverse events related to EN (P=0.027).

Discussion

Nutrition is a fundamental component in the survival and recovery of critically ill patients, particularly those who have suffered a stroke. Stroke patients often experience significant physiological and metabolic changes that contribute to malnutrition, including dysphagia, impaired consciousness, inflammatory responses, and increased energy demands. Malnutrition in critically ill stroke patients is associated with poor clinical outcomes, including delayed recovery, increased susceptibility to infections, prolonged hospital stays, and higher mortality rates. Therefore, ensuring adequate nutrition and understanding the factors influencing nutritional status in this patient population is essential for improving patient care and recovery outcomes (Schott et al., 2024; Lu et al., 2023; Mehta et al., 2022).

The demographic characteristics of the studied critically ill stroke patients provide valuable insights into the population at risk of malnutrition. This study findings revealed a nearly balanced distribution between male and female, which suggests that both gender are equally susceptible to critical illness following a stroke. These findings are contradictory the findings of Branyan & Sohrabji, (2020) who reported that older females have a higher prevalence and worse outcome from stroke due to estrogen loss, hypertension, atrial fibrillation, diabetes, smoking, and sex-specific risk factors.

Regarding age distribution, the majority of patients aged between 56 and 60 years old, this may be explained by that with increase age the incidence of stroke increase due to various pathophysiological changes in the cardiovascular and cerebrovascular systems. Vascular aging is a major factor that leads to atherosclerosis and elevated blood pressure.

The anthropometric measurements of the studied patients revealed a significant decline in anthropometric indicators among critically ill stroke patients in the 7th day when compared with the baseline data. These findings may be explained by progressive muscle wasting and fat loss, which are hallmark signs of acute malnutrition in critically ill patients. These results align with Mousa et al., (2022) who reported that the observed changes in anthropometric measurements can be attributed to increased catabolic activity, inflammatory responses, and the metabolic stress associated with critical illness.(Mousa et al., 2022)

The findings of this study indicate that pale skin and edema are significant clinical indicators of malnutrition in critically ill stroke patients, reflecting both micronutrient deficiencies and altered fluid balance. Pale skin and pale conjunctiva are commonly associated with iron deficiency anemia, which can result from inadequate nutritional intake, impaired absorption, or chronic inflammation leading to functional iron sequestration. Anemia in critically ill patients contributes to tissue hypoxia and impaired wound healing, further exacerbating poor clinical outcomes. Edema, particularly generalized edema, is often a sign of hypoalbuminemia, a consequence of inadequate protein intake, increased catabolism, and systemic inflammation.

The results of this study indicate that hemoglobin and potassium levels are critical biochemical indicators of malnutrition in critically ill stroke patients, A significant decline in hemoglobin levels over the course of ICU admission suggests the presence of anemia, which can result from inadequate dietary iron, vitamin B12. Similarly, the significant decrease in potassium levels may indicate inadequate dietary intake, gastrointestinal losses, or fluid imbalances common in critically ill patients receiving enteral feeding.

These findings highlight a significant gap between the required, dispensed, and delivered nutrients (calories, protein, and enteral volume) among critically ill stroke patients. The results demonstrate that the delivered nutritional intake was significantly lower than the required amounts. These discrepancies suggest challenges in achieving adequate nutritional support, which may be attributed to occurrence of complications such as feeding intolerance manifested by gastrointestinal complications such as abdominal distension and vomiting or interruptions in enteral nutrition due to medical procedures or inadequate knowledge of staff regarding nutritional care which was the most prevalent cause of interruption. These results align with the findings of Zeng et al., (2024) who reported that identified abdominal distension and vomiting as common barriers to enteral nutrition, leading to suboptimal nutrient delivery. Also, these results supported by the findings of Sato et al., (2023) who reported that similar nutritional deficits in critically ill patients, emphasizing the impact of inadequate energy and protein intake on muscle wasting, immune dysfunction, and prolonged hospital stay.

The findings of this study illustrate that there is a relationship between nutritional adequacy and patient’s age and sex. Age was found to be a significant predictor of calorie adequacy suggesting that as age increases, nutritional intake in terms of caloric sufficiency improves. This may be explained by that younger patients may experience more pronounced metabolic stress responses, including hypermetabolism and catabolism, which can increase energy demands and contribute to greater caloric deficits. This finding aligns with Pontzer et al., (2021) who reported that older patients may exhibit reduced metabolic rates and lower energy expenditures compared to younger individuals, making it easier to achieve calorie adequacy despite feeding interruptions.

The study also highlights a significant association between protein adequacy and NIHSS scores and mNUTRIC score suggesting that patients with more severe neurological deficits were more prone to inadequate protein intake. This may be explained by patients with severe stroke (higher NIHSS scores) often experience profound dysphagia, impaired consciousness, and reduced gastrointestinal motility, leading to feeding difficulties and prolonged interruptions in enteral nutrition

The findings of this study illustrate that higher mNUTRIC scores indicate greater metabolic stress and systemic inflammation, which drive hypercatabolism and increased protein breakdown, leading to accelerated muscle wasting and malnutrition. Patients with elevated mNUTRIC scores are often more critically ill, requiring prolonged mechanical ventilation, sedation, and vasopressor support, which contribute to feeding interruptions, gastrointestinal intolerance, and suboptimal protein delivery.

The results of this study reveal that the fear of adverse events or medical risks, such as diarrhea or aspiration among nurses administering enteral feeding can significantly contribute to malnutrition. Concerns about complications may lead to conservative feeding practices, delayed initiation, or frequent interruptions of nutrition resulting in inadequate caloric and protein intake.

The results of this study indicate that vasopressors use, contribute to nutritional inadequacy. This may be explained by that vasopressors induce splanchnic vasoconstriction, reducing blood flow to the gastrointestinal (GIT) tract and impairing digestion, absorption, and gut motility.

The findings of this study demonstrate that frequent and prolonged interruptions in EN, often due to procedures, diagnostic imaging, gastrointestinal intolerance, or hemodynamic instability, contribute to cumulative energy and protein deficits, increasing the risk of malnutrition and muscle wasting.

The results of this study present that misinterpretation of gastric residual volumes (GRVs) in enteral feeding is a significant factor contributing to malnutrition in critically ill stroke patients. GRVs are commonly used as an indicator of gastric emptying and feeding tolerance; however, excessive reliance on GRVs, particularly when arbitrary cutoff values lead to unnecessary feeding interruptions, results in inadequate nutrient delivery and cumulative caloric and protein deficits.

The results of this study also indicate that the timing of enteral feeding initiation in critically ill stroke patients is a crucial factor influencing nutritional status, clinical outcomes, and the risk of malnutrition. Delayed initiation of enteral nutrition, often due to hemodynamic instability, concerns about aspiration, or procedural delays, results in prolonged fasting and cumulative caloric and protein deficits, exacerbating muscle catabolism and increasing the risk of malnutrition-related complications.

The results of this study highlight that abdominal distension is a significant factor affecting enteral feeding adequacy and increasing the risk of malnutrition in critically ill stroke patients. These results align with Kumar et al., (2024) who found that abdominal distension is commonly associated with gastrointestinal dysmotility, delayed gastric emptying, and impaired intestinal absorption, all of which are prevalent in critically ill patients due to stroke-induced autonomic dysfunction, immobility, and medication effects.

Conclusion

Malnutrition approximately occurs in all critically ill stroke patients admitted to the ICU and is influenced by multiple factors related to patient, staff and therapeutic management. Patient-related factors included age, sex, abdominal distension, hemodynamic instability using vasopressor and mNUTRIC. Staff-related factors such as misinterpretation of gastric residual volumes, fear of adverse events or medical risks, delays in enteral nutrition initiation and unscheduled basic nursing care were the common staff related factors contributing to malnutrition in this study. Prolonged enteral nutrition withholding and waiting for therapeutic procedures (surgical intervention), significantly impact caloric and protein intake were found to be therapeutic management related factors in this study. Addressing these challenges through evidence-based interventions is essential for improving patient outcomes.

Recommendations

In line with the findings of the study, the following recommendations are made:

Recommendations regarding clinical practice:

- The critical care nurses (CCNs) should assess continuously the patients who undergone tube feeding withhold for continuity of the required food if the patient's condition allows.
- Conduct a thorough assessment, including a comprehensive nutritional assessment for the patients suffering from acute stroke.
- Collaborate with other nutrition care team members to develop and implement individualized nutritional care plans for critically ill stroke patients at risk of malnutrition.

Recommendations regarding education and training:

- Incorporate the specific risk factors of malnutrition in stroke patients into undergraduate critical care nursing curricula to enhance early identification and intervention skills.
- Conduct meetings, conferences and implement training programs to teach healthcare providers how to identify, prevent, and manage malnutrition in stroke patients.

Recommendations regarding administration:

- Establish a multidisciplinary nutrition care team and reinforce the role of clinical dietitians within the ICU team and train nurses to effectively manage nutrition-related care.
- Develop and apply evidence-based, age-specific enteral feeding protocols, including clear guidelines for initiating, interrupting, and resuming feeds to ensure nutritional adequacy.
- Provide essential equipment for nutritional assessment, regularly monitor hospital diet intake, and standardize documentation and follow-up practices to optimize nutritional care.

Recommendations regarding future research:

- Conduct the study on a large sample size to enhance generalizability, explore the impact of early nutritional support on stroke outcomes, and support the development of nursing-led protocols for timely nutritional interventions.

Author contributions

Nadia Taha Mohamed Ahmed, professor: Supervision all thesis stages such as, writing thesis protocol, development and translation of tools. She also helped the student in research methodology, interpretation of results, study discussion, conclusion, recommendation, and organizing references.

Fikrat Ahmed Fouad El-Sahn, Professor: Supervision all thesis stages such as, writing thesis protocol, development and translation of tools. She also helped the student in research methodology, interpretation of results, study discussion, conclusion, recommendation, and organizing references.

Heba Mohamed Mustafa Ismail, Lecturer: Supervision all writing thesis protocol, data collection, results, and references.

Gamal Abdelnasser Mahmoud Ahmed, Demonstrator: Conceptualization, preparation, methodology, implementation of the sessions, investigation, formal analysis, data analysis, writing-original draft, writing-manuscript & editing. All authors read and approved the final manuscript.

Table (1): Distribution of the studied critically ill stroke patients according to demographic data.

Demographic data	Categories	(n=80)	
		No.	%
Sex	Male	38	47.5%
	Female	42	52.5%
Age (Years)	43-≤50 Yrs	6	7.5%
	+50-≤55 Yrs	20	25.0%
	+55-≤60 Yrs	54	67.5%
	Mean ± S.D.	56.2 ± 3.97	
	Range	43 – 60	
	Median	57	

Table (2): Distribution of studied critically ill stroke patients according to risk for malnutrition based on Modified Nutrition Risk in Critically Ill (mNUTRIC) Score on admission.

	Categories	(n=80)	
		No.	%
mNUTRIC	Low risk (≤4)	58	72.5%
	High risk (5-9)	22	27.5%
	Mean ± S.D.	3.54 ± 1.45	
	Range	1 – 7	

Table (3): Comparison between anthropometric measurements of studied critically ill stroke patients on admission and after 7 days.

Anthropometric measurements	1st day (n=80)	7th day (n=80)	Test of Significance (p value)
	Mean ± S.D.	Mean ± S.D.	
Mid-upper arm circumference (cm)	32.84 ± 4.5	31.23 ± 4.35	Paired t=20.1 (p<0.001***)
Triceps skin fold thickness (mm)	21.6 ± 4.21	18.98 ± 4.18	Paired t=42.98 (p<0.001***)
Knee height (cm)	50.16 ± 3.75	50.16 ± 3.75	Paired t N/A
Body weight (Kg)	77.4 ± 13.08	72.6 ± 12.79	Paired t=20.84 (p<0.001***)
Body height (Ht) (cm)	163.42 ± 8.99	163.42 ± 8.99	Paired t N/A
Body Mass Index (BMI)	29.58 ± 5.72	27.74 ± 5.57	Paired t=20.4 (p<0.001***)

Table (4): Comparison of the studied critically ill stroke patients regarding signs of malnutrition in the 1st and 7th day.

Signs of malnutrition	1st day (n=80)		7th day (n=80)		Test of Significance (p value)
	No.	%	No.	%	
Pale skin	34	42.5%	80	100.0%	McNemar=44.02 (p<0.001***)
Pale conjunctiva	32	40.0%	80	100.0%	McNemar=46.02 (p<0.001***)
Dry mouth	7	8.8%	79	98.8%	McNemar=70.01 (p<0.001***)
Generalized Edema	7	8.8%	39	48.8%	McNemar=30.03 (p<0.001***)
Dry Skin	3	3.8%	14	17.5%	McNemar=9.09 (p<0.001***)
Scaling Skin	1	1.3%	1	1.3%	McNemar=N/A

Table (5): Comparison of the studied critically ill stroke patients regarding biochemical values in the 1st and 7th day.

Biochemical values	1st day (n=80)	7th day (n=80)	Test of Significance (p value)
	Mean ± S.D.	Mean ± S.D.	
Hemoglobin (g/dL)	11.82 ± 1.72	10.16 ± 1.62	t=21.18 (p<0.001***)
Urea (mg/dL)	55.76 ± 36.3	64.78 ± 71.88	t=1.34 (p>0.05)
Creatinine (mg/dL)	1.28 ± 1.12	1.16 ± 0.9	t=1.29 (p>0.05)
Sodium (mmol/L)	137.45 ± 5.4	138.4 ± 7.32	t=1.30 (p>0.05)
Potassium (mmol/L)	4.12 ± 0.6	3.98 ± 0.58	t=2.45 (p<0.05*)

Table (6): Comparison between required, dispensed and delivered nutrients over 7 consecutive days.

	Mean difference	Value	Test of significance	
		Mean ± S.D.	Paired t	P
Calories (kcal)	Required : Delivered	831.97 ± 249.56	29.82	p<0.001***
	Required : Dispensed	371.15 ± 213.96	15.51	p<0.001***
	Dispensed : Delivered	460.83 ± 148.79	27.70	p<0.001***
Protein (g)	Required : Delivered	93.52 ± 22.57	37.07	p<0.001***
	Required : Dispensed	67.85 ± 23.74	25.56	p<0.001***
	Dispensed : Delivered	25.67 ± 12.07	19.01	p<0.001***
Enteral Volume (ml)	Required : Delivered	706.07 ± 277.26	22.78	p<0.001***
	Required : Dispensed	200 ± 0	N/A	
	Dispensed : Delivered	506.07 ± 277.26	16.33	p<0.001***

Table (7): Distribution of studied critically ill stroke patients according to adequacy of nutrition received.

Adequacy of received nutrition		(n=80)	
		No.	%
Calories	Mild Underfeeding (50% - <90%)	50	62.5 %
	Moderate Underfeeding (30% - <50%)	28	35.0 %
	Severe Underfeeding (<30%)	2	2.5 %
Protein	Moderate Underfeeding (30% - <50%)	26	32.5 %
	Severe Underfeeding (<30%)	54	67.5 %
Enteral volume	Mild Underfeeding (50% - <90%)	71	88.75 %
	Moderate Underfeeding (30% - <50%)	5	6.25 %
	Severe Underfeeding (<30%)	4	5.0 %

Table (8): Nutritional intervention related data of studied critically ill stroke patients.

Nutritional intervention related data	Mean	Std. Deviation
Time of initiation EN after ICU admission (hrs.)	8.08	10.41
Number of EN withholdings	6.44	2.22
Average duration EN withholdings per one interruption (hrs.)	5.48	7.03
Total duration of EN withholdings during the 7 days (hrs.)	29.27	17.41

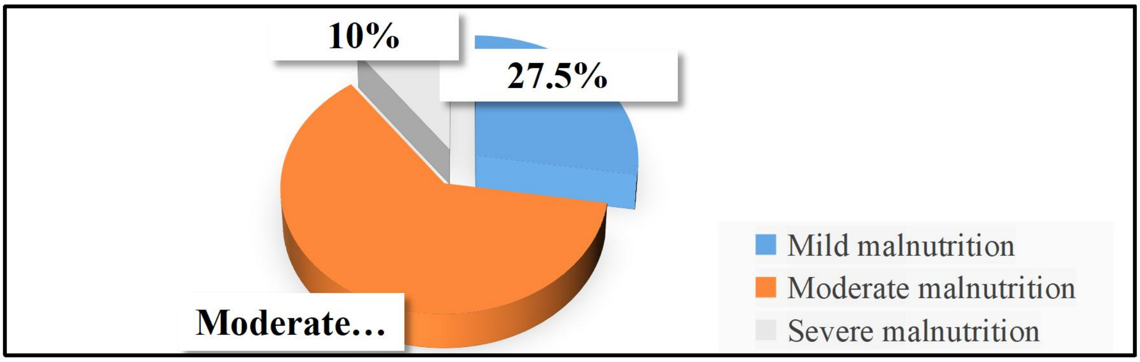

Figure 1: Distribution of the studied critically ill stroke patients according to the malnutrition after 7 days.

Table (9): Relationship between nutritional adequacy and causes of enteral nutrition withholding.

	Feeding intolerance		Hemodynamic instability		Mechanical complications		Therapeutic procedures	Unscheduled basic nursing care and competing patient care priorities	Fear of adverse events or medical risks associated with EN such as aspiration or diarrhea	Misinterpretation of GRVs (Delay gastric emptying)	Delays in obtaining enteral nutrition formula for new admission patient
	Vomiting	Abdominal distension	Hypotension or shock	Vasopressor use	Tube dislodgement	Tube blockage					
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Adequacy of calories											
▪ Severe underfeeding	-	-	-	-	-	-	2(100%)	2(100%)	2(100%)	2(100%)	-
▪ Moderate underfeeding	2(7.1%)	4(14.3%)	10(35.7%)	10(35.7%)	2(7.1%)	3 (10.7%)	6(21.4%)	18(64.3%)	26(92.9%)	21(75%)	10(35.7%)
▪ Mild underfeeding	-	-	8(16%)	8(16%)	-	13 (26%)	8(16%)	44(88%)	44(88%)	31(62%)	14(28%)
MCP	MCP=0.169	MCP=0.043*	MCP=0.216	MCP=0.216	MCP=0.169	MCP=0.121	MCP=0.076	MCP=0.073	MCP=0.503	MCP=0.186	MCP>0.999
Adequacy of protein											
▪ Severe underfeeding	2(3.7%)	2(3.7%)	16(29.6%)	16(29.6%)	2(3.7%)	9 (16.7%)	4(7.4%)	44(81.5%)	47(87%)	38(70.4%)	17(31.5%)
▪ Moderate underfeeding	-	2(7.7%)	2(7.7%)	2(7.7%)	-	7 (26.9%)	12(46.2%)	20(76.9%)	25(96.2%)	16(61.5%)	7(26.9%)
MCP	MCP=0.556	MCP=0.592	MCP=0.043*	MCP=0.043*	MCP=0.556	MCP=0.372	MCP<0.001***	MCP=0.766	MCP=0.264	MCP=0.454	MCP=0.797
Adequacy of enteral volume											
▪ Severe underfeeding	2(50%)	2(50%)	-	-	-	-	2(50%)	2(50%)	2(50%)	2(50%)	2(50%)
▪ Moderate underfeeding	-	-	2(40%)	2(40%)	1(20%)	-	-	1 20%)	5(100%)	5(100%)	-
▪ Mild underfeeding	-	2(2.8%)	16(22.5%)	16(22.5%)	1(1.4%)	16 (22.5%)	14(19.7%)	61(85.9%)	65(91.5%)	47(66.2%)	22(31%)
MCP	MCP=0.002**	MCP=0.012*	MCP=0.791	MCP=0.791	MCP=0.209	MCP=0.178	MCP=0.573	MCP=0.007**	MCP=0.065	MCP>0.999	MCP>0.999
Malnutrition (GLIM)											
▪ Severe malnutrition	-	-	-	-	-	-	-	6(75%)	8(100%)	6(75%)	4(50%)
▪ Moderate malnutrition	1(2%)	3(6%)	14(28%)	14(28%)	-	12 (24%)	10 (20%)	41(82%)	47(94%)	37(74%)	13(26%)
▪ Mild malnutrition	1(4.5%)	1(4.5%)	4(18.2%)	4(18.2%)	2(9.1%)	4 (18.2%)	6(27.3%)	17(77.3%)	17(77.3%)	11(50%)	7(31.8%)
MCP	MCP=0.556	MCP>0.999	MCP=0.823	MCP=0.823	MCP=0.084	MCP=0.641	MCP=0.156	MCP>0.999	MCP=0.027*	MCP=0.105	MCP=0.679

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