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Relationship between nutritional intake and the duration of mechanical ventilation use in critical patients

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ABSTRACT

Introduction: The incidence of malnutrition among critically ill patients undergoing treatment in intensive care unit (ICU) ranges from 30-50%. This malnutrition is primarily attributed to hypercatabolism and hypermetabolism, leading to significant reductions in energy and protein levels. Muscle atrophy, particularly in the diaphragm, exacerbates respiratory muscle fatigue, making breathing difficult and necessitating prolonged mechanical ventilation. This prolonged ventilation often leads to complications such as infections, delayed recovery, and extended hospital stays.

Objectives: This study aims to examine the relationship between energy, protein, carbohydrate, and fat intake and the duration of mechanical ventilation in patients receiving collaborative clinical nutrition (first group) versus non-collaborative clinical nutrition (second group) at the Wahidin Sudirohusodo Hospital from 2020 to 2022.

Methods: This retrospective cohort study employed an analytical observational approach and was conducted at the Medical Records section of Wahidin Sudirohusodo Hospital in Makassar. The study included 37 patients who had been on mechanical ventilation for ≥ 8 days and received enteral and parenteral nutrition. The patients were divided into two groups: one receiving collaborative clinical nutrition and the other receiving only enteral nutrition. Data collection involved 24-hour food recall recording, blood tests for routine parameters, and assessment of the duration of mechanical ventilation.

Results: The study found significant differences in nutritional intake between the collaborative clinical nutrition (first group) and the non-collaborative clinical nutrition (second group). The collaborative group had higher mean energy (first group 1199.70 vs. second group 848.73), protein (first group 22.38 vs. second group 17.29), and fat (first group 22.62 vs. second group 15.31) intake, while carbohydrate intake was lower in the first group (55.30 vs. second group 63.86). These differences were statistically significant with a p-value < 0.05. This study also found a correlation between nutritional intake and duration of mechanical ventilation use. There was a negative correlation between energy, protein and fat intake while carbohydrate intake had a positive correlation.

Conclusions: The study concludes that the collaborative clinical nutrition (first group) had higher nutritional intake compared to the non-collaborative (second group). The First group exhibited higher energy, protein, and fat intake. Nutritional intake also had a significant influence on mechanical ventilation (per day). The lower the energy, protein, and fat intake, while the carbohydrate intake increased, the longer the use of mechanical ventilation.

KEYWORDS

Long-term ventilation, enteral nutrition, parenteral nutrition.

INTRODUCTION

Patients who are critically ill suffer from severe illnesses that cause dysfunction of vital organs and pose an imminent risk of death in the absence of immediate intervention. However, such conditions may be potentially reversible. Critical illness often in-

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volves hypercatabolism induced by stress hormones and inflammatory cytokines, with hormones such as glucagon, cortisol, and catecholamines rapidly breaking down macronutrients to meet elevated energy demands. This process is further compounded by a number of factors, including prolonged immobilization, nosocomial infections, sedation, and the use of muscle relaxants, which collectively increase protein catabolism. Consequently, inadequate nutritional intake combined with heightened metabolic demands can result in malnutrition in these patients[1,2].

The incidence of malnutrition among critical patients undergoing treatment in intensive care unit (ICU) ranges from 30-50%[3]. These patients often experience respiratory failure or circulatory dysfunction, triggering hypermetabolic and hypercatabolic responses and exacerbating malnutrition. Hypercatabolism and hypermetabolism significantly reduce energy and protein levels, particularly in muscle tissues such as the diaphragm, leading to muscle atrophy and respiratory muscle fatigue, thereby complicating breathing and necessitating prolonged mechanical ventilation. Continuously, this can lead to complications such as infections, delayed recovery, and extended hospitalization.

Research by Koontalay (2021) demonstrated that nutritional status, timing of initial enteral administration, and target calorie requirements were statistically associated with the duration of mechanical ventilation. This highlights the importance of assessing nutritional status in critical patients. Regular monitoring of daily target calorie requirements for patients receiving enteral nutrition (EN) every 7 days can facilitate the implementation of appropriate nutritional strategies to reduce mechanical ventilation duration in the ICU. Nutritional support based on guidelines can effectively shorten mechanical ventilation duration by providing tailored nutritional care, assessing nutritional status, and optimizing enteral nutrition promptly after hemodynamic stabilization or as soon as possible[4].

A study by Sutrisnawati (2021) using a cross-sectional approach found that Nutric score correlated with the duration of mechanical ventilation in the ICU. Adequate energy and protein intake were significantly negatively correlated with mechanical ventilation duration. Prolonged mechanical ventilation serves as an outcome measure for evaluating ICU care quality. Malnutrition among ICU patients increases morbidity, mortality, costs, and mechanical ventilation duration[5].

Factors contributing to prolonged mechanical ventilation include underlying diseases, poor nutritional status, electrolyte imbalances such as hypokalemia, hypomagnesemia, and hypophosphatemia, age-related factors, drug side effects, and ICU-acquired weakness[6].

This research contributes to the understanding of the relationship between energy intake and mechanical ventilation duration in intensive care settings. Providing appropriate energy support to critical patients can help prevent catabolic states, promote gluconeogenesis, facilitate glycemic control, and enhance successful weaning from mechanical ventilation.

LITERATURE REVIEW

Metabolic Response of Critical Patients

The metabolic response to stress in critically ill patients represents an essential adaptive mechanism for survival. This response encompasses various mechanisms that have persisted throughout evolution. These include the stimulation of sympathetic nerves, secretion of pituitary hormones, peripheral resistance to stress, and modulation of metabolic factors to enhance the availability of energy substrates to vital tissues. Consequently, there are alterations in energy production pathways and utilization of alternative substrates due to a loss of control over energy substrate utilization. Clinical manifestations of the metabolic stress response include changes in energy delivery, stress-induced hyperglycemia, alterations in body composition, and psychological and behavioral disturbances. Notably, the loss of muscle protein and its functionality is a significant consequence of metabolic stress.

Specific therapeutic interventions, such as hormone supplementation, increased protein intake, and early mobilization, are currently under investigation for their efficacy in mitigating the adverse effects of metabolic stress[3].

The metabolic response to stress involves both neuroendocrine and inflammatory/immune components. Additionally, hormones released from adipose tissue and the digestive tract play pivotal roles in mediating metabolic responses. The neuroendocrine component of the response initiates stimulation in areas proximal to the hypothalamus, including the paraventricular nucleus and locus coeruleus. Upon detection of stress signals and transmission to the central nervous system, a prototypical response ensues, leading to activation of the sympathetic nervous system, the hypothalamic-pituitary axis, and subsequent alterations in inflammatory, immune, and behavioral responses

Factors Influencing the Use of Mechanical Ventilation

In the ICU, mechanical ventilation serves as a lifesaving breathing aid. The weaning process refers to the transition from full ventilation to successful extubation following the first spontaneous breathing trial (SBT). Typically, most ventilation management (VM) deployments conclude within a week. Successful weaning hinges upon the strength of respiratory muscles and respiratory drive[7]. Failure to wean indicates respiratory failure stemming from various contributing factors. Patients requiring mechanical ventilation for over two weeks face a 30% in-hospital mortality rate and a 60% mortality rate within one year[7].

Prolonged mechanical ventilation in critically ill patients can lead to complications such as leg muscle atrophy, diminished functional capacity, and diaphragm dysfunction. Reduced basal pulmonary respiratory pressure levels contribute to respiratory failure. Brainstem lesions may disrupt both upper and lower respiratory functions, leading to abnormal breathing patterns, hypoventilation, respiratory acidosis, and consequently, prolonged mechanical ventilation[8].

Complications of Mechanical Ventilation

Ventilation using high tidal volumes can elevate vascular filtration pressure, leading to damage to endothelial capillaries, epithelium, and basement membrane, ultimately resulting in lung rupture. Mechanical trauma induces leakage of fluid, protein, and blood into tissue and air spaces, or in some cases, air leakage into tissue spaces. These pathological events trigger an inflammatory response, potentially compromising the body's defense against infection. Elevated peak inspiratory volume and pressure, along with high mean airway pressure, serve as predisposing factors for lung injury[9].

In patients with Acute Respiratory Distress Syndrome (ARDS) of severe degree (P/F ratio ≤200 mmHg), Fan et al. recommend treatment in a prone position for a minimum of 12 hours daily. The prone position is believed to enhance ventilation by increasing lung perfusion, expanding end-expiratory lung volume, and promoting more uniform distribution of tidal volume throughout the lung. However, it is important to note that the prone position may also elevate the risk of endotracheal tube displacement[10].

Mechanical ventilation weaning involves gradually reducing the level of mechanical ventilation support, allowing the patient to assume a greater proportion of their ventilation. This can be achieved through attempts at spontaneous breathing or a gradual reduction in mechanical ventilation support[11].

Nutritional Status

No specific nutrition scoring system tailored for ICU patients has been validated to date. Existing nutritional screening tools like NRS 2002 and the Malnutrition Universal Screening Tool (MUST) were not specifically designed for critically ill patients. Recently, a new risk assessment tool called NUTRIC has been proposed, which considers factors such as age, disease severity assessed by APACHE II and Sequential Organ Failure Assessment (SOFA) scores, comorbidities, duration from hospital to ICU admission, and presence of inflammation as indicated by interleukin-6 levels. The composite NUTRIC score has shown correlation with mortality, and there's evidence suggesting that nutritional intervention may reduce mortality in patients with a high NUTRIC score (>5)[12].

Nutritional therapy plays a crucial role in managing critical illness by mitigating the metabolic response to stress, preventing oxidative cellular damage, and modulating the immune response. Strategies for nutritional modulation of the stress response include early initiation of enteral nutrition, provision of appropriate macro- and micronutrients, and meticulous glycemic control[13].

However, it's essential to avoid overfeeding, as it can have adverse effects. Excessive nutrient intake can exacerbate respiratory failure by increasing carbon dioxide production. A surplus of calories (rather than an excess of carbohydrates specifically) leads to increased CO2 production and, consequently, heightened respiratory workload. Indirect calorimetry is a valuable tool for accurately assessing energy requirements and identifying cases of underfeeding or overfeeding[13].

The Relationship between Malnutrition and Respiratory Disorders

Patients experiencing acute or chronic respiratory failure are susceptible to, or may already present with, nutrition-related complications. Nutritional support plays a crucial role in their treatment, as further deterioration can directly impact respiratory function, leading to worsened outcomes. Specific nutritional guidelines exist for the management and treatment of both acute and chronic respiratory failure[13].

Critical patients suffering from respiratory system failure or circulatory dysfunction often experience hypermetabolic and hypercatabolic reactions, leading to malnutrition. This is characterized by significant reductions in energy and protein levels, particularly due to muscle wasting, including the diaphragm, which can result in muscle atrophy and respiratory muscle fatigue. These complications contribute to prolonged mechanical ventilation, increasing the risk of infections, delayed recovery, and extended hospitalization[2,4,14,15].

Implementing low-carbohydrate, high-fat nutritional therapy can mitigate exogenous glucose loads, enhance glycemic control, reduce inflammation, and improve clinical outcomes, including respiratory function. Administering such therapy to critical patients has the potential to alleviate hyperglycemia, enhance ventilation, and shorten hospital stays[16]. Lowering carbohydrate intake can decrease insulin levels, a pivotal hormone involved in promoting anabolic states and fat storage, thereby improving cardiometabolic function and facilitating weight loss[17].

MATERIAL AND METHODS

Study design and participation: This study was conducted at Wahidin Sudirohusodo Hospital, Makassar in September 2023 – Febuary 2024. This study design is a retrospective cohort with an analytical observational approach in critical patients using mechanical ventilation who were hospitalized in the Intensive Care Unit (ICU) of Wahidin Sudirohusodo Hospital.

The research sample comprised all critical patients undergoing mechanical ventilation treatment in the ICU at Wahidin Sudirohusodo Hospital from January 2020 to December 2022, who met the inclusion criteria. Out of 551 ICU patients meeting the inclusion criteria, 37 patients underwent mechanical ventilation for ≥ 8 days. A total of 514 patients were excluded, including 19 pediatric patients, 357 deceased patients, and 47 patients who could not be assessed for the mNutric score. Additionally, 24 patients were ventilated for less than 2 days, and 67 patients were ventilated for 2-7 days.

The research was divided into two groups: the first group comprised patients who collaborated with clinical nutrition and received nutritional therapy through both enteral and parenteral intake, while the second group consisted of patients who did not engage in clinical nutrition collaboration and received enteral nutrition only. Data collection involved recording 24-hour food intake, routine blood tests, electrolyte levels, total bilirubin, urea, creatinine, blood sugar, Glasgow Coma Scale (GCS), blood gas analysis, assessment, and calculation of the duration of mechanical ventilation in days.

The study's inclusion criteria encompass patients aged 18 years or older who are treated in the ICU and require mechanical ventilation for both medical and surgical reasons. Additionally, it includes patients in the ICU regardless of whether they are receiving clinical nutrition. Specifically, patients who have been using mechanical ventilation for 8 days or more are eligible.

On the other hand, the exclusion criteria rule out patients who have died, those with incomplete data, individuals younger than 18 years, patients with a mean arterial pressure (MAP) below 64, those with an average nutritional intake of zero, patients who have used mechanical ventilation for one day or less due to short weaning, and those with a Sequential Organ Failure Assessment (SOFA) score greater than 20, indicating a severe condition and signs of failure.

Research variables: In this study, there are nutritional variables as independent variables consisting of energy intake (kcal), protein intake (%), carbohydrate intake (%), and fat intake (%). Meanwhile, the dependent variable in this study was the duration of mechanical ventilation use (days).

Ethical consideration: This research has received approval from the Health Research Ethics Commission (HREC) of the Faculty of Medicine, Hasanuddin University.

Statistical analysis: The data obtained are collected according to the type of data, and then the appropriate statistical method is selected. Independent t-test and Mann-Whitney test were used to analyze the nutritional intake of both groups. To evaluate the correlation between the nutritional intake and the duration of the use of mechanical ventilation (per day), the Spearman correlation test was performed.

RESULTS

From the results of the research, as depicted in Table 1, shows the characteristics, two main groups emerged: the first (cooperative) group and the second (non-cooperative) group. There were 21 patients (56.8%) in the first group, compared to 16 patients (43.2%) in the second group, indicating a majority of patients in the study were cooperative.

Regarding gender distribution, 24 patients (64.9%) were males, while 13 patients (35.1%) were females, suggesting a

Table 1. Characteristics of Respondents Based on Category

Characteristics		n	%
Group	First	21	56.8
	Second	16	43.2
Gender	Man	24	64.9
	Woman	13	35.1
Age	18-60	30	81.1
	> 60	7	18.9
Education	No school - elementary school	10	27.0
	Middle School - High School	17	45.9
	Bachelor	10	27.0
Upper Arm Circumference	19 - 21.9	4	10.8
	22 - 23	2	5.4
	> 23	31	83.8
BMI	< 18.5	4	10.8
	18.5 - 22.9	15	40.5
	23 - 25	10	27.0
	25 - 29.9	7	18.9
	> 30	1	2.7
Diagnosis	Surgery	26	70.3
	Neurology	7	18.9
	Airway disease	4	10.8
Comorbid	0 - 1	32	86.5
	> 1	5	13.5
Vasopressors	Yes	29	78.4
	No	8	21.6
APACHE	< 15	14	37.8
	15 - 19	12	32.4
	20 - 28	11	29.7
SOFA	< 6	20	54.1
	6 - 9	15	40.5
	> 9	2	5.4
Amount		37	100.0

slight male predominance. In terms of age, the majority of patients (81.1%) fell between the ages of 18 and 60 years, with only 7 patients (18.9%) being aged above 60 years.

Education-wise, 10 patients (27.0%) had received no formal education or attended elementary school, 17 patients (45.9%) had completed middle to high school education, and 10 patients (27.0%) had higher education (college level or above).

Based on Upper Arm Circumference and BMI (Body Mass Index) parameters, the majority of patients had Upper Arm Circumference measurements exceeding 23 (83.8%), while the BMI ranged between 18.5 to 22.9 for 40.5% of patients.

The diagnoses recorded in the table indicated that the majority of patients (70.3%) were diagnosed with surgical issues, followed by neurology (18.9%) and respiratory tract diseases (10.8%).

Regarding the number of comorbidities, most patients (86.5%) had 0-1 comorbidities. Furthermore, 29 patients (78.4%) utilized vasopressors.

Based on the APACHE (Acute Physiology and Chronic Health Evaluation) and SOFA (Sequential Organ Failure Assessment) scores, the majority of APACHE scores fell within the range of 15-19 (32.4%), while most SOFA scores were below 6 (54.1%)

Table 2 illustrates the distribution of patients based on energy, protein, carbohydrate, and fat intake in specific studies or populations. For energy intake, it is noted that 20 patients (54.1%) had an intake of less than 1000 calories, while 17 patients (45.9%) had an intake exceeding 1000 calories. Regarding protein intake, 18 patients (48.6%) consumed less than 56 grams, whereas 19 patients (51.4%) consumed more than 56 grams. In terms of carbohydrate intake, 21 patients (56.8%) consumed less than 149.88 grams, and 16 patients (43.2%) consumed more than 149.88 grams. Lastly, for fat intake, 21 patients (56.8%) consumed less than 28.04 grams, while 16 patients (43.2%) consumed more than 28.04 grams, which is a notable finding

Table 2. Table of patient distribution based on energy, protein, carbohydrate and fat intake

Variables		n	%
Energy (kcal)	< 1000	20	54.1
	≥ 1000	17	45.9
Proteins (gr)	< 56	18	48.6
	≥ 56	19	51.4
Carbohydrate (gr)	< 149.88	21	56.8
	≥149.88	16	43.2
Fat (gr)	< 28.04	21	56.8
	≥ 28.04	16	43.2
Duration of mechanical ventilation (per day)	8-15	24	64,9
	> 15	13	35,1
Amount		37	100.0

The results of the analysis in table 3 show that there are significant differences in energy and macronutrient intake between the first and second groups. The first group had significantly higher energy and protein intake, while the second group had significantly higher carbohydrate intake. These differences in intake patterns can provide important information regarding eating habits and potential health risks in the two groups.

Based on the results of the correlation analysis, significant relationships were observed between nutritional intake and the duration of mechanical ventilation as seen on table 4 below. A significant negative relationship was found between energy intake and the duration of mechanical ventilation ($r = -0.389$, $p = 0.017$). This indicates that lower energy intake is associated with longer mechanical ventilation use.

Table 3. Comparison of Nutrition Consumption between First Group and Second Group

Group	First Group			Second Group			p value
	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	
Energy (kcal)	1199.70	404.44	1266.00	848.73	243.42	819.30	0.017**
Protein %	22.38	4.81	20.40	17.29	4.41	16.85	0.002*
Carbohydrate %	55.30	8.49	52.87	63.86	7.41	64.66	0.003*
Fat %	22.62	7.87	21.54	15.31	4.09	15.36	0.002**

* Indepemdent t test. ** Mann Whitney test.

Similarly, there was a significant negative relationship between the percentage of protein intake and the duration of mechanical ventilation (r = -0.394, p = 0.016), suggesting that lower protein intake is correlated with longer mechanical ventilation use.

Conversely, a significant positive relationship was observed between the percentage of carbohydrate intake and the duration of mechanical ventilation (r = 0.338, p = 0.041). This implies that higher carbohydrate intake is associated with longer mechanical ventilation use.

Furthermore, a significant negative relationship was found between the percentage of fat intake and the duration of mechanical ventilation (r = -0.427, p = 0.008), indicating that lower fat intake is correlated with longer mechanical ventilation use. All of these results are the same when compared between the first and second groups.

DISCUSSION

Differences between energy, protein, carbohydrate and fat intake and the duration of mechanical ventilation use in critical patients with clinical nutrition collaboration (first group) and non-cooperation with clinical nutrition (second group) in the intensive care unit (ICU)

The analysis reveals that the first (cooperation) group exhibits higher nutritional intake compared to the second group. Specifically, the first group demonstrates higher energy, protein, and fat intake, albeit with lower carbohydrate intake. These differences are statistically significant, indicating a distinct nutritional profile between the first group and second groups.

This analysis underscores the significance of closely monitoring nutritional intake in mechanically ventilated patients, particularly concerning carbohydrates and fats. Disparities in nutritional intake between the first and second groups offer valuable insights for the nutritional management of patients undergoing mechanical ventilation therapy.

This research aligns with Hellena's 2018 study on ventilator utilization in critical patients at Arifin Achmad Hospital Pekanbaru, which also highlights the significant association between patients' nutritional status and ventilator use. Hellena's findings reveal that among 475 ventilated patients, malnutrition was prevalent, with 40% of adult hospital patients and 60% of hospitalized patients experiencing worsening nutritional status. Moreover, severe malnutrition was observed in 30% of critical patients on ventilators. Thus, nutritional status emerges as a critical factor influencing both ventilator use and patient health.

Protein helps repair the patient's body tissues and speeds up the recovery process. Proper nutritional intake can help patients reduce the risk of post-surgical complications and speed up the recovery process. Proper nutritional intake can also help patients correct electrolyte and fluid imbalances that may occur after surgery. Proper nutritional intake can help patients restore optimal body function after surgery. To pay attention to nutritional intake in patients undergoing mechanical ventilation, strategies can be implemented such as paying attention to food intake, micronutrient intake, energy intake, protein intake, and fluid intake. Ensure that patients consume foods that contain the necessary carbohydrates, proteins, fats, fibre and vitamins. Ensure patients consume micronutrients such as selenium, zinc, magnesium, iron, calcium, copper, carotene, vitamin B6, vitamin B12, and vitamin E necessary for the body. Ensure that patients consume proteins necessary for repairing body tissues and improving metabolism. Ensure patients consume the necessary fluids to reduce the risk of dehydration and electrolyte disturbances. Paying attention to the nutritional intake of patients undergoing mechanical ventilation can help patients restore normal body condition and reduce the risk of post-surgical complications.

The optimal protein requirement for critically ill patients is 1.2 - 2.0 g/kg. Smith et al indicated that a nitrogen intake of 300 mg/kg (~1.8 g/kg protein) is required for gastroenterological patients to maintain nitrogen balance. Shaw et al

Table 4. Correlation of nutritional intake (energy, protein, carbohydrate and fat) intake with duration of mechanical ventilation use (per day)

Nutritional intake	Duration of mechanical ventilation (per day)					
	First group		Second group		All groups	
	r value*	p value*	r value*	p value*	r value*	p value*
Energy (kcal)	-0.396	0.076	-0.543	0.030	-0.389	0.017
Protein (%)	-0.450	0.041	-0.473	0.064	-0.394	0.016
Carbohydrates (%)	0.238	0.298	0.579	0.019	0.338	0.041
Fat (%)	-0.650	0.001	-0.307	0.247	-0.427	0.008

* Spearman correlation test

showed that when 1.5 g/kg proteinper day was given to patients with fallow sepsis, maximum protein stimulation could be achieved. Nitrogen balance reflects energy and protein intake. Nitrogen balance checks should be carried out regularly in the supervised care of critical patients to restore to an anabolic state. A negative nitrogen balance indicates protein catabolism and reflects inadequate protein intake. In critically ill patients, the goal of nutritional support is to achieve nitrogen balance in the range of + 2 to + 4 gper day. However, several studies have shown that nitrogen balance tests (urine urea nitrogen (UUN)) are not always sensitive for determining total urine nitrogen, which may significantly impair the prediction of nitrogen balance[18,19].

The American Society of Parenteral and Enteral Nutrition (ASPEN) recommends that ICU patients should begin enteral nutrition (EN) support within 24 to 48 hours of admission or after resuscitation to maintain systemic immune function and major organ structures. Therefore, the American Society of Parenteral and Enteral Nutrition (ASPEN) recommends that 75.6% of patients receive sufficient protein and 61.2% meet energy needs within the first 7 days. Thereby improving respiratory function, structure, improving weaning ability and reducing the length of use of mechanical ventilation[4].

Nutritional support is essential for mechanically ventilated patients to meet their energy requirements and to maintain or even to enhance their muscle strength for facilitating ventilator weaning. Carbon dioxide production may be determined in part by the composition of enteral or parenteral nutrition, which in turn may affect the weaning process. Published reports of respiratory failure precipitated by high carbohydrate feeding have drawn attention to the carbohydrate and fat content of the patient's diet. In patients with chronic or acute retention of carbon dioxide (Hypercapnia), one goal of dietary therapy is to decrease carbon dioxide production[20]. High carbohydrate intake in mechanically ventilated patients leads to excessive carbon dioxide production, so 50% carbohydrate intake is given to replenish respiratory muscle glycogen[21]. High carbon dioxide production can precipitate acute respiratory failure in patients with chronic pulmonary disease and can complicate weaning in ventilator dependent patients. Because the complete combustion of fat yields less carbon dioxide than combustion of either carbohydrate or protein, a high fat diet may be preferable for patients with pulmonary disease[20].

Excess carbohydrate intake leads to increased CO_2 production, which will delay the successful discontinuation of mechanical ventilation and will prolong the length of hospitalisation[22]. Fat is an important source of energy and plays a role in maintaining healthy cells and cell membranes. In addition, fat is also required for the absorption of fat-soluble vitamins, which are important for respiratory and immune system functions. Thus, adequate nutritional intake, especially energy, protein, carbohydrate, and fat, can contribute to patient recovery and influence the length of mechanical ventilation use.

Sindhwani, 2006. Enteral feeding is given as early as possible, to avoid loss of muscle mass. Protein intake is 15%-20% (1- 2 g/kg) body weight. Fat intake in mechanically ventilated patients is more moderate at 20%-40% fat to avoid high carbohydrate intake[23]. Metabolism of macronutrients yields carbon dioxide (CO_2) oxidative end products with CHO producing the greatest amount. The respiratory quotient [RQ, CO_2 produced over oxygen (O_2) consumed] is a measure that reflects substrate utilization. When the value exceeds 1.0, O_2 consumption must increase, resulting in an increased work of breathing[20].

The relationship between energy, protein, carbohydrate, and fat intake and duration of mechanical ventilation use in non-cooperative clinical nutrition patients in the intensive care unit (ICU) of Wahidin Sudirohusodo Hospital in 2020-2022

The results of the analysis highlight a significant impact of mechanical ventilation duration on nutritional intake. Prolonged use of mechanical ventilation correlates with lower energy, protein, and fat intake, while carbohydrate intake tends to increase. Specifically, as the duration of mechanical ventilation extends, energy and protein intake decrease, carbohydrate intake rises, and fat intake declines. This suggests that mechanical ventilation can influence an individual's eating patterns and overall nutritional intake, underscoring the importance of monitoring its use.

Understanding the relationship between energy, protein, carbohydrate, and fat intake and the duration of mechanical ventilation in non-cooperating patients receiving clinical nutrition is crucial in the context of caring for patients requiring respiratory support. Adequate nutritional intake plays a vital role in maintaining patient health and supporting the healing process. Energy intake, in particular, is essential for meeting the body's metabolic demands, including respiratory function maintenance. Patients with sufficient energy intake tend to exhibit better resilience to stress and infection, factors that can impact the duration of mechanical ventilation.

A cross-sectional study by Sutrisnawati (2021), emphasizes the correlation between Nutric score and the duration of mechanical ventilation in the ICU. Adequate energy and protein intake were found to be significantly negatively correlated with mechanical ventilation duration. Prolonged mechanical ventilation is a critical outcome parameter used to assess ICU care quality. Malnutrition among ICU patients not only increases morbidity, mortality, and costs but also prolongs the duration of mechanical ventilation[5].

Previous study by Koontalay (2021) to identify the impact of nutritional factors on mechanical ventilation duration for critical patients. As a result of this study, patients with high risk malnutrition may require longer duration, about 50.34 days for mechanical ventilation. However, if adequate calories target requirement is quicker than 1 hour, it can decrease mechanical ventilation duration used by 8 days[4].

CONCLUSION

The results of the analysis indicate that the first group exhibited a higher nutritional intake compared to the second group. The first group exhibited a higher energy intake, as well as a higher protein and fat intake. However, the first group exhibited a lower carbohydrate intake. This difference was statistically significant, indicating that the first group had a different nutritional profile than the second group. Nutritional intake also had a significant influence on mechanical ventilation (per day). The lower the energy, protein, and fat intake, while the carbohydrate intake increased, the longer the use of mechanical ventilation.

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