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Case Report

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Nutrition Support in Critically Ill Cancer Patient Receiving Extracorporeal Membrane Oxygenation: A Case Report

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ABSTRACT

Adequate nutritional support is crucial in preventing complications and improving outcomes in critically ill patients. Extracorporeal membrane oxygenation (ECMO) is a mode of supportive care for patients with respiratory and/or cardiac failure. ECMO patients frequently exhibit a hypermetabolic state characterized by protein catabolism and insulin resistance, which can lead to malnutrition. Nutritional therapy is a vital component of intensive care, but its optimal administration for ECMO patients is unknown. This case report aims to provide insights into effective nutritional management for critically ill patients undergoing ECMO therapy. The patient was a 72-year-old male with a history of gastric and lung cancer who underwent a lobectomy complicated by bronchopleural fistula, postoperative bleeding, pneumonia, and acute respiratory distress syndrome (ARDS). The patient's nutritional status was assessed indicating a high risk of malnutrition, using the modified Nutrition Risk in the Critically Ill (mNUTRIC) Score. Nutritional support was administered based on the recommendations of European Society for Clinical Nutrition and Metabolism (ESPEN) and the American Society for Parenteral and Enteral Nutrition (ASPEN), with energy requirements set at 25–30 kcal/kg/d and protein requirements set at 1.2–2.0 g/kg/day. The patient received parenteral nutrition until the enteral nutrition target amount was reached, with zinc supplements for wound healing. The study highlights the need for further research on proactive and effective nutritional support for ECMO patients to improve compliance and prognosis.

Keywords: Enteral nutrition; Nutritional support; Malnutrition

INTRODUCTION

Critically ill patients are at risk of metabolic deterioration leading to loss of lean body mass [1]. Nutritional support has been shown to reduce mortality rates and shorten hospital stays in these patients, making it a crucial aspect of their management [2,3]. Extracorporeal membrane oxygenation (ECMO) is a mode of supportive care for patients with respiratory and/or cardiac failure [4]. It helps to minimize lung damage from mechanical ventilation and maintain exchange of oxygen and carbon dioxide during recovery [4-7]. The coronavirus disease 2019 pandemic has led to a rise in the use of mechanical ventilatory support, particularly ECMO, in intensive care unit (ICU) worldwide [5]. The increasing prevalence of ECMO therapy in Korea has been associated with improved patient survival rates and treatment outcomes [8]. However, patients undergoing ECMO therapy often show a hypermetabolic state that is characterized by protein breakdown and insulin resistance, leading to protein-energy malnutrition [9]. They also receive concomitant vasoactive agents, steroids, and prolonged sedation, which can impair their gastrointestinal functions and make it difficult to initiate and continue enteral nutrition (EN) [5,9]. The guidelines on ECMO do not offer adequate direction regarding the application of medical nutrition therapy for these individuals. [5]. This case report aims to provide basic data on effective nutritional management for cancer patients receiving ECMO therapy in the ICU by assessing their clinical characteristics, nutritional status, and compliance with EN support. The study was approved by the National Cancer Center Ethics Committee (NCC2022-0130).

CASE

A 72-year-old male patient was diagnosed with early gastric cancer (T1aN0) in 2006 and underwent laparoscopic subtotal gastrectomy. In 2021, he was diagnosed with lung cancer (T1cN2) and underwent a right lobectomy in February 2021. As a result of early satiety at the time of admission, his intake was 30% lower than usual. The physical examination revealed a mild deficit, while the nutritional status evaluation revealed stage B (moderate malnutrition) with a score of 7 by The Scored Patient-Generated Subjective Global Assessment (PG-SGA) and an Eastern Cooperative Oncology Group (ECOG) score of 1. On postoperative day (POD) #13, a bronchopleural fistula occurred. Primary repair of the bronchopleural fistula and muscle flap (primary closure of bronchopleural fistula [BPF] after debridement and reinforcement with serratus muscle flap) was performed. On POD #24, postoperative bleeding occurred, and after control of the hemorrhage, he was admitted to the ICU at POD #35 due to pneumonia and acute respiratory distress syndrome (ARDS). All modified Nutrition Risk in the Critically Ill (mNUTRIC) Score items presented in **Table 1** were recorded within 24 hours after ICU admission. A mNUTRIC Score of 5 or higher was classified as a high score. A clinical dietitian assessed the patient's nutritional status with American Society for Parenteral and Enteral Nutrition (ASPEN)/Academy of Nutrition and Dietetics (AND) within 48 hours after ICU admission. According to the mNUTRIC Score tool, the patient has a score of 6 (Acute Physiology and Chronic Health Evaluation [APACHE] II = 32, Sequential

Table 1. mNUTRIC Score items

Variable	Range	Point	Case	Total	Result
Age (yr)	< 50	0		6	High score
	≥ 50 and < 75	1	√		
	≥ 75	2			
APACHE II	< 15	0			
	≥ 15 and < 20	1			
	≥ 20 and < 28	2			
	≥ 28	3	√		
SOFA	< 6	0	√		
	≥ 6 and < 10	1			
	≥ 10	2			
Number of co-morbidities	0–1	0			
	≥ 2	1	√		
Days from hospital to ICU admission	≥ 0 and < 1	0			
	≥ 1	1	√		

Sum of points 5–9, high score: Associated with worse clinical outcomes. Sum of points 0–4, low score: These patinets have a low malnutrition risk.
mNUTRIC, modified Nutrition Risk in the Critically Ill; APACHE II, Acute Physiology and Chronic Health Evaluation II; SOFA, Sequential Organ Failure Assessment; ICU, intensive care unit.

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Table 2. Changes of clinical characteristics

Characteristics	Intensive care unit (days)							
	0	7	14	21	28	31	38	45
Weight (kg)	45.5	46.8	46.6	57.4	59.4	61.0	59.0	60.6
Energy intake (kcal/day)	1,528	1,150	1,437	1,360	1,468	1,620	966	1,580
Protein intake (g/day)	72	69	77	81	84	97	51	94
Albumin (g/dL)	2.6	3.4	2.8	2.4	2.1	2.1	2.3	2.7
Hemoglobin (g/dL)	8.1	12.0	6.3	7.4	7.3	6.1	6.8	7.7
PLT (10^3/μL)	310	128	95	68	57	64	89	88
CRP (mg/dL)	11.4	4.4	3.6	8.5	13.3	15.6	16.3	16.6
BUN (mg/dL)	22	54	91	76	42	40	35	41
Cr (mg/dL)	1.6	1.1	3.3	1.0	0.9	0.8	0.7	0.7

PLT, platelet; CRP, C-reactive protein; BUN, blood urea nitrogen; Cr, creatinine.

Organ Failure Assessment [SOFA] = 1 point), indicating a high risk for malnutrition. The ASPEN/AND results indicate severe malnutrition related to chronic illness. At the time of admission to the ICU, the patient's consciousness level was alert (eye [Glasgow Coma Scale; GCS]: 4, verbal [GCS]: 5, motor [GCS]: 6), and venovenous (VV) ECMO was inserted due to ARDS from the second day of stay in the ICU. Continuous renal replacement therapy (CRRT) was not administered, a ventilator was used, and norepinephrine was not administered. At ICU admission, the patient's height was 161 cm, weight was 45.4 kg, and body mass index (BMI) was 17.5 kg/m^2. The patient's changes of clinical characteristics presented in **Table 2**.

Following the National Cancer Center intensive care unit nutrition support protocol, which is based on the recommendations of the European Society for Clinical Nutrition and Metabolism (ESPEN) and the ASPEN, the objective was to maintain the patient's current body weight and supplement protein. Energy requirements recommended the supply of 25–30 kcal/kg/day, and protein requirements for critically ill patients are presented as 1.2–2.0 g/kg/day actual body weight, with up to 2.5 g/kg/day considered according to the ASPEN guidelines [1]. In addition, **Figure 1** in the ASPEN guidelines recommend considering 24-hour urine collections weekly to determine nitrogen balance and guide adjustments in protein supplementation [10]. For critically ill patients admitted to the Nutrition Support Team (NST) in the ICU, urinary urea nitrogen testing is conducted within 24 hours of admission to assess nitrogen balance and evaluate the target protein level. This evaluation allows for the assessment of an appropriate protein requirement plan based on the individual needs of the patient.

During the 40 days of ICU stay, the patient was referred to the NST at ICU length of stay (LOS) #0, #7, #14, #21, #31, and #45 to assist with diet interventions.

ICU LOS#0

Following ARDS, the patient was admitted to the ICU and referred to the intensive nutrition treatment team for EN. EN was carried out through the naso-gastric route through the Leven tube, and the initial feeding injection target amount was 300 kcal/day was injected at a rate of 20 mL/hr using a feeding pump. EN 500, 35 mL/hr was fed, and the insufficient amount of calories was supplemented with parenteral nutrition (PN) (Winuf Peri inj) according to the pharmacist's opinion, and PN reduction was planned according to the EN increase. The patient's target caloric intake was set at 1,400 kcal (30 kcal/kg), and the target protein requirement was set at 84 g (1.8 g/kg). The feeding amount was increased by 300 kcal/day every day according to patient compliance.

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Guideline for administering supplemental protein

1. Supplemental protein will be administered to deliver –1.5 g/kg of protein/day (1.2–1.5 g/kg in the medical patient and 1.5–2 g/kg in burn, surgical, and trauma patient after the patient is deemed ready to start enteral feeding.
2. Protein supplementation will be administered as a bolus via the nasal/oral feeding tube, 2–4 times per day depending on product used.
3. Enteral feeding will be ordered according to current institutional protocols but supplemental protein will be calculated and administered independently of recommended formula intake.
4. Supplemental protein will be reduced by 50% if a patient received 75% of caloric intake over the previous 24-hour period.
5. Once the patient reaches target caloric intake for 48 hours, supplemental protein will be calculated to include the protein contained in the enteral formula and adjusted accordingly.
6. Consider 24-hour urine collections weekly in order to determine nitrogen balance and to guide adjustments in protein supplementation.

Contraindications to administering supplemental protein

Absolute:
1. Any situation where enteral feeding is not indicated (see ICU nutritional support guidelines)
2. Hepatic encephalopathy
3. Chronic renal failure
4. Attending physician (intensivist) preference

Relative:
1. In the case of acute kidney injury (AKI) and not receiving renal replacement therapy (serum creatinine > 1.5 mg/dL), reduce protein target to 1.2 g/kg (lower end of ASPEN recommendations for patients with AKI)
2. Elderly, age > 80 years

Figure 1. Guideline for administering supplemental protein.
ASPEN, American Society for Parenteral and Enteral Nutrition; ICU, intensive care unit; AKI, acute kidney injury.

ICU LOS#2

VV-ECMO and a mechanical ventilator were applied to prevent exacerbation of BPF while maintaining lung rest and minimal ventilator pressure. For patients receiving mechanical ventilation, the Penn State 2003 equation is used to calculate energy requirements [11]. However, for patients receiving ECMO, the energy requirements are typically set at 25–30 kcal/kg due to changes in Ve values. Based on the application of Ve 1.5 and Tmas 36.5, the estimated energy requirement using the Penn State 2003 equation is 1,000–1,100 kcal/day (22 kcal/kg) [12]. The patient restarted EN on the second day after ECMO was initiated.

ICU LOS#7

The patient was receiving Levophed at a range of 3–18 mcg, and EN was administered at a rate of 60 mL/hr, providing 76% of the calculated energy requirements.

ICU LOS#14

After tracheostomy, bloody oozing continued, and plateletpheresis was performed. Due to this procedure, EN was administered at 80% of the calculated energy requirements.

ICU LOS#21

A pressure sore developed on the coccyx side, so zinc supplementation was planned for wound healing. The National Cancer Center offered zinc supplements to patients with pressure ulcers who have undergone nutrition management. For PN formulation, Zincpam 10 mg is prescribed intravenously three times per week, and zinc sulfate monohydrate syrup (light zinc syrup 5 mL/package, containing 10 mg of zinc per packet) is prescribed daily for oral administration only.

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Table 3. The amount of protein received from enteral nutrition, parenteral nutrition, and nitrogen balance in the intensive care unit

LOS	Protein requirement (g)	Intake protein (g)	UUN (g/day)	Nitrogen balance (−4 to +4)
LOS#27	90	84	12	−2.56
LOS#34	96	96	10	1.36
LOS#41	96	90	9	1.40

LOS, length of stay; UUN, urinary urea nitrogen.

ICU LOS#31

Patient use of vasopressor was maintained at 3 mcg, and EN was proceeding tolerably. The required amount was planned as 1,600 kcal/day by referring to the opinion of the NST. To assess the adequacy of protein intake, a 24-hour urinary urea nitrogen (UUN) test was performed on the patient. The patient's protein requirement was set at 2.0 g/kg/day based on the weight at ICU admission (45.4 kg) with the goal of wound healing the fistula, and as a result of LOS#27 nitrogen balance (with a target protein of 90 g, intake protein of 84 g, and UUN of 12), 93% of the required protein was supplied, but nitrogen balance resulted in negative balance (−2.56) was adjusted by slightly increasing the target amount. LOS#34 and LOS#41 nitrogen balance maintained a positive balance. **Table 3** summarizes nitrogen balance.

ICU LOS#45

There was an event where the patient intermittently experienced apnea and changed the mechanical ventilator mode. The guardian signed the do not resuscitate (DNR) consent. The patient expired 2 days after signing the DNR on ICU LOS#49.

Figures 2 and **3** display the changes in the supplied nutrient amount (%) versus the required amount of nutrition during ICU admission.

DISCUSSION

Enteral nutrition is recommended as a priority for critically ill patients because it helps maintain intestinal function, control stress and immune response, and improve disease

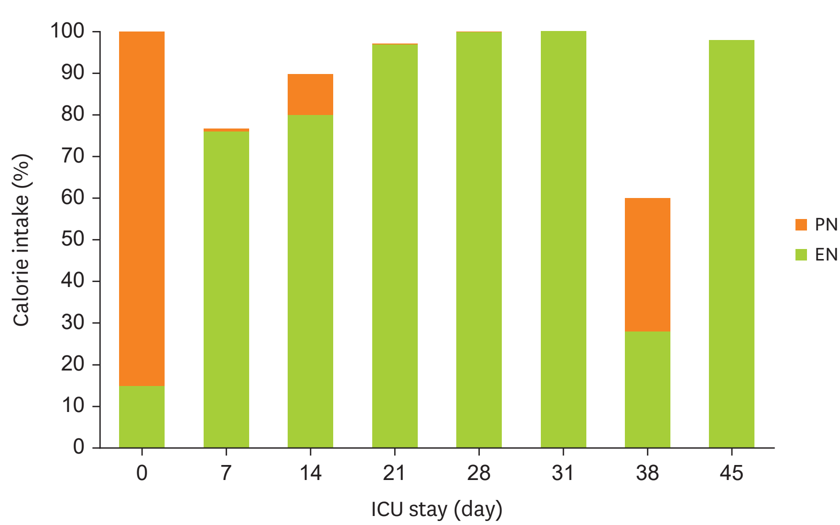

Figure 2. Change in energy intake through EN and PN during the ICU stay.
EN, enteral nutrition; PN, parenteral nutrition; ICU, intensive care unit.

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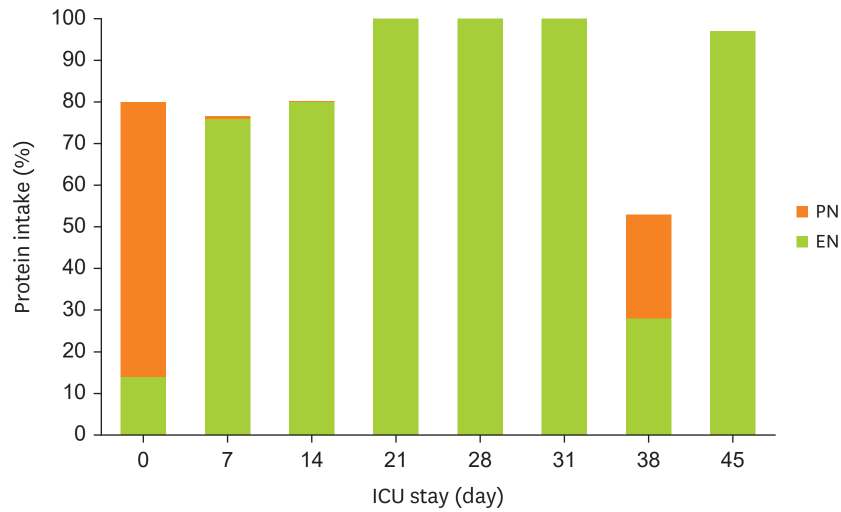

Figure 3. Change in protein intake through EN and PN during the ICU stay.
EN, enteral nutrition; PN, parenteral nutrition; ICU, intensive care unit.

severity [1,3]. However, when the patient's hemodynamic status is unstable, or a high-dose vasopressor is administered, it becomes difficult to administer EN, and nutritional support is often neglected [5]. Therefore, in this study, we sought to determine the safety and efficacy of EN by analyzing ECMO cases. PG-SGA result revealed that the nutritional status of the subjects was stage B (moderately malnourished) at the time of hospital admission. Based on symptoms such as anorexia, body fluid retention, weight loss, and biochemical indicators in the blood, such as a decrease in platelet and an increase in C-reactive protein, it was possible to conclude that the patient was in a state of potential malnutrition with a compromised immune status. According to the mNUTRIC Score tool, the patient indicated a high risk for malnutrition at the ICU admission. The mNUTRIC Score, an ICU patient nutrition screening tool recommended by ESPEN, was used to assess the patients, and ASPEN was used to assess nutritional status in our hospital's intensive care unit. Heyland et al. previously proposed a novel scoring tool, the NUTRIC score, which is the first nutritional risk assessment tool developed and validated specifically for ICU patients [13]. The NUTRIC score is a nutrition screening tool for critically ill patients and is performed on every patient in the ICU. The NUTRIC score consists of six variables such as age, APACHE II, SOFA, co-morbidities, the days from hospital to ICU admission, and interleukin (IL)-6. Since IL-6 is not readily measurable in most hospitals, a mNUTRIC Score that excludes IL-6 is used instead. The National Cancer Center routinely conducts 24-hour UUN tests upon ICU admission for patients who do not undergo CRRT under the NST discussion. If the nitrogen balance is negative, additional protein modular supplements or amino acids via intravenous may be considered. In this case, EN was maintained after ECMO implementation, and PN was administered until the EN target amount was reached. This is consistent with the report by Bear et al. [6], which stated that PN was administered in 4%–30% of ECMO patients to ensure the stability of early EN. In addition, Ferrie et al. [9], who studied 86 ECMO patients, reported that early EN was initiated on average 13.1 hours after admission to the ICU, which is similar to this case. Early EN administration to venoarterial ECMO patients showed an average of 4-day in reaching the target rate. However, more than half of the patients demonstrated good compliance without adverse events [14]. Kim et al. [15] reported that the point of EN support was 2.0 ± 1.6 days after ECMO insertion, indicating that the in-hospital intensive care unit EN protocol, which provides nutritional support within 24 to 48 hours of entering the intensive care unit, was followed correctly. It was discovered on the third day of ECMO insertion that up to 80% of the supply target had been met [15]. Our study results were similar to the start date of EN in our case. Therefore, if EN is administered to patients undergoing ECMO therapy with metabolic stability in mind, it is believed to be an effective method of nutrient delivery. There are no known guidelines for EN support for patients undergoing ECMO therapy at this time. Providing EN to patients undergoing ECMO therapy in the intensive care unit has been associated with good compliance, and clinically improved prognosis was shown in previous studies. Although the patient in this case experienced a decline in condition and expired, as seen in other studies, meeting the nutrition requirement for patients receiving ECMO is expected to result in improved clinical outcomes. This case showed the gradual progression and compliance of EN in a patient undergoing ECMO, with satisfactory adherence observed. With the increasing use of ECMO, there is a growing need for ongoing research to ensure proactive and effective nutritional support for ECMO patients.

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