International Journal of Medical Anesthesiology

E-ISSN: 2664-3774
P-ISSN: 2664-3766
www.anesthesiologypaper.com
IJMA 2024; 7(3): 37-39
Received: 10-05-2024
Accepted: 16-06-2024

Asmaa Badr Eldin Opoda
Anesthesiologist, Department of Surgical Intensive Care and Pain Medicine, Faculty of Medicine, Tanta University, Tanta, Egypt

Taysser Mahmoud Abdulrahim
Anesthesiologist, Department of Surgical Intensive Care and Pain Medicine, Faculty of Medicine, Tanta University, Tanta, Egypt

Mona Blough El Mourad Fayad
Anesthesiologist, Department of Surgical Intensive Care and Pain Medicine, Faculty of Medicine, Tanta University, Tanta, Egypt

Sohair Moustafa Soliman
Anesthesiologist, Department of Surgical Intensive Care and Pain Medicine, Faculty of Medicine, Tanta University, Tanta, Egypt

Nadia Hassan Fattouh
Anesthesiologist, Department of Surgical Intensive Care and Pain Medicine, Faculty of Medicine, Tanta University, Tanta, Egypt

Corresponding Author:
Asmaa Badr Eldin Opoda
Anesthesiologist, Department of Surgical Intensive Care and Pain Medicine, Faculty of Medicine, Tanta University, Tanta, Egypt

High protein intake and physical exercise during critical illness to maintain muscle mass in ICU patient

Asmaa Badr Eldin Opoda, Taysser Mahmoud Abdulrahim, Mona Blough El Mourad Fayad, Sohair Moustafa Soliman and Nadia Hassan Fattouh

DOI: https://doi.org/10.33545/26643766.2024.v7.i3a.484

Abstract
Throughout periods of critical illness, the breakdown of proteins exceeds the body's ability to build new proteins, resulting in a negative net protein synthesis. The impact of protein dosage on critically ill individuals is of great interest, since it is believed to enhance clinical outcomes by reducing protein loss throughout critical illness and aiding in the recovery of patients throughout later stages. Early protocolized physical therapy, along with high protein nutritional supplementation in critically illness, individuals on mechanical ventilation attenuated the decrease in the cross-sectional area and rectus femoris muscle thickness and enhance clinical outcomes (minimize delirium, days of ventilation, and intensive care unit (ICU) length of stay (LOS)) contrasted to usual care.

Keywords: Physical exercise, maintain muscle mass, ICU patient

Introduction
Skeletal muscle has a crucial role in determining clinical, physiologic, and metabolic outcomes. At the time of admission to the ICU, 20% to 70% of those receiving care are found to have low muscle mass. Additionally, after 10 days of being admitted to the ICU, there may be a further 30% drop in the mass of quadriceps muscle **[1].** Interestingly, a decrease in mass of muscles is also seen up to 6 and 12 months after being discharged from the ICU [2]. Skeletal muscle atrophy is connected to worse health outcomes, longer hospital stays, and higher death rates. It has been shown that raised levels of tumor necrosis factor-α and interleukin 6 have associations with muscle atrophy, and these factors are also linked to a higher risk of infection in older persons [3].
Implementing early mobilization with conventional physical therapy may mitigate the impact of Intensive Care Unit Acquired Weakness (ICUAW) by enhancing muscular strength, shortening the duration of mechanical ventilation, lowering the length of stay in the ICU, and improving in-hospital functionality [4]. Empirical evidence has shown that this is both secure and practicable [5].
The use of nutritional supplements, particularly the consumption of dietary protein, has gained more attention as a technique to maintain skeletal muscle wellness when paired with standardized therapy in the ICU. Among some non-ICU groups, the combination of high protein meals with rehabilitation programs has shown positive treatment outcomes in terms of maintaining skeletal muscle strength, mass, and functionality. This combination has shown to be more effective compared to either rehabilitation or nutrition alone [6].

Mechanism of muscle weakness in critical illness
The atrophy of skeletal muscles in patients with critical illnesses is caused by various factors, which includes catabolic signaling (Such as insulin resistance (IR) and proinflammation) and malnutrition resulting from inadequate caloric and protein intakes. This leads to a drop in protein synthesis caused by reduction in the intake of amino acids, which are necessary for protein synthesis [7]. Moreover, when critically ill individuals have decreased activity and IR, it is probable that they also demonstrate anabolic resistance, that refers to the diminished capacity of the muscles to take in and utilize amino acids for the production of protein [8]. In order to meet the body's increased protein requirements throughout severe illness, the breakdown of skeletal muscle is accelerated to release amino acids for the production of

other proteins that are necessary for immunological function. This process leads to muscular atrophy [9]. However, bed rest, regardless of sickness, may lead to muscular atrophy as a consequence of decreased blood supply, which hinders the supply of amino acids to skeletal muscle [10]. Additionally, the decline in muscle quality may be seen when fat infiltrates the skeletal muscle, perhaps leading to impaired metabolism of glucose and fat in the muscle [11].

Proteins turn over and journey in critical illness

The cellular protein content is controlled by the precise regulation of anabolism (The process of the synthesis of proteins) and catabolism (The process of breaking down proteins into amino acids). In a healthy person, the anabolic and catabolic processes are in equilibrium, resulting in a net protein synthesis of zero [12].

Throughout periods of severe illness, the breakdown of proteins in the body is greater than the production of new proteins, resulting in a negative balance of protein synthesis. The equilibrium between anabolism and catabolism, and consequently the buildup of protein in a cell, is influenced by various physiological stimuli. These include neurohormonal signaling, inflammation, and the presence of nutrients. Adequate nutrient availability, particularly amino acids, is crucial for protein synthesis. However, if the supply of essential amino acids is reduced, protein anabolism is significantly impaired. The synthesis of proteins occurs when there is a sufficient quantity of amino acids and energy in the right proportion. If one or more amino acids are not present or are insufficient, the process of protein synthesis ceases. This triggers protective metabolic systems that are designed to avoid cell death. On a daily basis, around 3% to 5% of cellular protein undergoes recycling, which is a metabolically intensive process that may require a substantial amount of cellular energy. Amino acids released throughout protein recycling may either be incorporated into an amino acid pool for the synthesis of new proteins, or they might be oxidized and utilized as a source of energy [12].

Amino acid oxidation occurs in the cell under several circumstances

- In the absence of glucose, protein catabolism occurs, releasing amino acids that may be turned into glucose.
- This process is a natural element of protein recycling. About 10% of all amino acids are metabolized to provide energy throughout regular metabolic processes.
- When there are too many amino acids, they are unable to be stored. Instead, they are oxidized and degraded to balance the availability of amino acids.

Protein supply is crucial for the preservation of muscle in both healthy individuals and those with medical conditions. The treatment of critical care now emphasizes measures to preserve muscle mass and functionality. It is considered safe and perhaps ideal to provide critically ill patients with 2-2.5 g/kg/d. Preliminary physiological research indicates that nitrogen balance is in a negative condition during periods of inflammation, and the extent of protein loss throughout sickness is directly proportionate to the severity of the damage. Severe protein malnutrition is linked to adverse clinical consequences, such as significant muscular weakness, reliance on ventilators for respiration, impaired wound healing, compromised immunological function, inability to perform basic daily tasks, and ultimately, mortality [12].

Early Physical Exercise

The primary objective of early physical therapy in the ICU is to avoid or minimize the occurrence of ICUAW by the implementation of targeted physical treatments that are tailored to the unique needs of critically ill patients and their surroundings. Early physical exercise, when appropriate and safe for ICU patients, can include passive, active-assisted, active, or resistance exercises. This can help to improve circulation, respiratory function, and strength of muscles, and potentially decrease the length of the ICU stay and improve overall outcomes [13].

Passive and active range of motion [14]

The physiotherapy approaches advised for clinical practice are categorized as active treatments for individuals who are capable of following instructions based on their conscious level, and passive therapies for individuals who are unable to do so [15].

For individuals who are unconscious, it is important to assess the daily range of motion for joint contractures and tone the muscles utilizing passive joint movements. Individuals who are at risk or already have joint contractures ought to receive daily sessions of stretching, splinting, or passive motions employing continuous passive motion (CPM) for a duration of 20 minutes.

For conscious patients: who can follow instructions active therapy modalities are required and to avoid joint contractures, it is suggested to do five active range of motion exercises daily. (70)

- To avoid atrophy of muscles and enhance its strength; active exercise (building up training component: frequency should be increased gradually from one to five times per day, intensity also increased gradually from low to high, type and time of repetition increased from eight till ten repetition per session and sets from one till three beside 20 minutes of active cycling).
- To enhance functional performance, it is essential to engage in mobility exercises that simulate real-life situations, such as transitioning from sitting on the side of the bed to sitting in a chair and then walking. Additionally, training in everyday activities should be included.

Passive ROM exercises for the upper limbs might be started early while the patient is in bed and can be progressively advanced to include active and resistance training [16].

Combining high protein intake with early physical exercise

While it is acknowledged that achieving optimal nutrition through a combination of proper diet, physical activity, and rehabilitation focused on building strength can lead to the best results, critically ill patients often consume less nutrition than recommended by the registered dietitian. This is primarily due to unplanned interruptions in feeding for medical procedures and difficulties in tolerating food. In addition, if a bedbound individual is given the recommended amount of nutrients but does not engage in effective exercise, their muscles will not be able to efficiently use amino acids as substrates for metabolism to

support muscular growth while maintaining the mass, structure, and functionality of skeletal muscles [17].

However, the implementation of high protein diets and physical exercise in the ICU setting must consider the following factors [18]

- **Medical Stability:** Patients must be stable enough to tolerate increased protein intake and physical activity.
- **Nutritional Needs:** Patients in the ICU often have complex nutritional requirements. A registered dietitian should assess each patient's needs and provide individualized recommendations for protein intake.
- **Type and Timing of Exercise:** The type and timing of physical exercise should be determined by a physical therapist or rehabilitation specialist in coordination with the medical team. It should be based on the patient's medical condition, overall strength, and endurance levels.
- **Monitoring:** Careful monitoring is essential to ensure patient safety. This includes monitoring vital signs, nutritional status, and response to exercise.
- **Gradual Progression:** Both protein intake and exercise intensity should be gradually increased as tolerated by the patient.
- **Interdisciplinary Approach:** A team approach involving physicians, nurses, dietitians, physical therapists, and other healthcare professionals is essential to coordinate care and optimize patient outcomes.

Financial support and sponsorship: Nil.

Conflict of Interest: Nil.

References

1. Dusseaux MM, Antoun S, Grigioni S, Béduneau G, Carpentier D, Girault C, *et al*. Skeletal muscle mass and adipose tissue alteration in critically ill patients. PLoS One. 2019;14:e0216991.
2. Hui DS, Wong KT, Ko FW, Tam LS, Chan DP, Woo J, *et al*. The 1-year impact of severe acute respiratory syndrome on pulmonary function, exercise capacity, and quality of life in a cohort of survivors. Chest. 2005;128:2247-2261.
3. Lo Buglio A, Bellanti F, Capurso C, Paglia A, Vendemiale G. adherence to mediterranean diet, malnutrition, length of stay and mortality in elderly patients hospitalized in internal medicine wards. Nutrients. 2019, 11.
4. Tipping CJ, Harrold M, Holland A, Romero L, Nisbet T, Hodgson CL. The effects of active mobilisation and rehabilitation in ICU on mortality and function: A systematic review. Intensive Care Med. 2017;43:171-183.
5. Nydahl P, Sricharoenchai T, Chandra S, Kundt FS, Huang M, Fischill M, *et al*. safety of patient mobilization and rehabilitation in the intensive care unit. systematic review with meta-analysis. Ann Am Thorac Soc. 2017;14:766-777.
6. Verceles AC, Serra M, Davis D, Alon G, Wells CL, Parker E, *et al*. Combining exercise, protein supplementation and electric stimulation to mitigate muscle wasting and improve outcomes for survivors of critical illness-The ExPrES study. Heart & Lung. 2023;58:229-235.
7. Ong C, Lee JH, Leow MKS, Puthucheary ZA. A narrative review of skeletal muscle atrophy in critically ill children: pathogenesis and chronic sequelae. Transl Pediatr. 2021;10:2763-2777.
8. McKendry J, Thomas ACQ, Phillips SM. muscle mass loss in the older critically ill population: potential therapeutic strategies. Nutr. Clin. Pract. 2020;35:607-16.
9. Obled C, Papet I, Breuillé D. Metabolic bases of amino acid requirements in acute diseases. Curr. Opin. Clin. Nutr. Metab. Care. 2002;5:189-197.
10. Frontera WR, Ochala J. Skeletal muscle: A brief review of structure and function. Calcif. Tissue Int. 2015;96:183-195.
11. Parry SM, Chapple LS, Mourtzakis M. exploring the potential effectiveness of combining optimal nutrition with electrical stimulation to maintain muscle health in critical illness: A narrative review. Nutr. Clin. Pract. 2018;33:772-789.
12. Madden AM, Smith S. Body composition and morphological assessment of nutritional status in adults: a review of anthropometric variables. J Hum Nutr. Diet. 2016;29:17-25.
13. Laurent H, Aubreton S, Richard R, Gorce Y, Caron E, Vallat A, *et al*. Systematic review of early exercise in intensive care: A qualitative approach. Anaesth. Crit. Care Pain Med. 2016;35:133-149.
14. Sommers J, Engelbert RH, Dettling-Ihnenfeldt D, Gosselink R, Spronk PE, Nollet F, *et al*. Physiotherapy in the intensive care unit: an evidence-based, expert driven, practical statement and rehabilitation recommendations. Clin Rehabil. 2015;29:1051-1063.
15. Bowman T, Mestanza Mattos FG, Salvalaggio S, Marazzini F, Allera Longo C, Bocini S, *et al*. Classification and Quantification of Physical Therapy Interventions across Multiple Neurological Disorders: An Italian Multicenter Network. J Clin. Med. 2023;12.
16. Trinity JD, Richardson RS. Physiological Impact and Clinical Relevance of Passive Exercise/Movement. Sports Med. 2019;49:1365-1381.
17. Verceles AC, Serra M, Davis D, Alon G, Wells CL, Parker E, *et al*. Combining exercise, protein supplementation and electric stimulation to mitigate muscle wasting and improve outcomes for survivors of critical illness-The ExPrES study. Heart Lung. 2023;58:229-235.
18. Van Zanten ARH, De Waele E, Wischmeyer PE. Nutrition therapy and critical illness: practical guidance for the ICU, post-ICU, and long-term convalescence phases. Crit. Care. 2019;23:368.

How to Cite This Article
Opoda ABE, Abdulrahim TM, El Mourad MBF, Sohair Soliman M, Fattouh NH. High protein intake and physical exercise during critical illness to maintain muscle mass in ICU patient. International Journal of Medical Anesthesiology 2024; 7(3): 37-39.