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CASE REPORT

The role of energy and protein adequacy in improving functional capacity in adult males with severe burn injury: A case series

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Abstract

Background: Burn injury represents a major global health problem with high mortality and disability rates, significantly affecting patients' quality of life, including in Indonesia. Patients with severe burns frequently experience a decline in functional capacity due to muscle weakness, which is exacerbated by the hypermetabolic response. Adequate daily caloric and protein intake is essential to preserve muscle mass and potentially improve patients' functional capacity.

Case report: The first case, a 39-year-old male with grade 2A–3 burn injury involving 35.5% of total body surface area (TBSA). Nutritional management was initiated at 10 kcal/kg body weight/day and protein 1 g/kg/day, then increased to 42 kcal/kg/day and 1.9 g/kg/day. The patient showed an improvement in the Functional Assessment for Burns–Critical Care (FAB-CC) score from 19 to 30. The second case, a 35-year-old male with grade 2A–3 burns involving 57.5% TBSA. Nutritional management was started at 10 kcal/kg/day and protein 0.4 g/kg/day, then gradually increased to 60 kcal/kg/day and protein 2.5 g/kg/day. The patient demonstrated improvement in the FAB-CC score from 3 to 20. Patients with burn injury experience hypermetabolism to support tissue repair and maintain vital organ function. Systemic inflammation and burn extent influence daily nutritional requirements. Adequate energy and protein intake play an important role in improving functional capacity in patients with burn injuries. All patients demonstrated increased daily energy and protein intake, which was associated with improved FAB-CC scores and functional capacity.

Conclusion: Both cases suggest that adequate energy and protein intake may support functional recovery in patients with burn injuries, as reflected by parallel improvements in FAB-CC scores during nutritional care. These findings underscore the importance of integrating optimal nutritional therapy within a multidisciplinary treatment strategy to maximize functional outcomes in burn patients.

Keywords: functional assessment for burns-critical care (FAB-CC), functional capacity, burn injury, nutrition

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Introduction

Burn injuries continue to represent an important public health burden in Indonesia, contributing substantially to both mortality and long-term morbidity. As a lower-middle-income country, Indonesia is affected by the broader global pattern in which burn-related deaths occur predominantly in low- and middle-income settings. The World Health Organization reports that more than 95% of fatal burn cases occur in these countries, while burns cause approximately 195,000 deaths worldwide each year, with almost two-thirds occurring in Africa and Southeast Asia. In the Indonesian context, flame burns and gas explosion-related injuries are frequently reported and are commonly associated with extensive total body surface area involvement.[1,2] Patients with severe burns often experience a decline in functional capacity due to muscle weakness during intensive care, which is exacerbated by the post-burn hypermetabolic response. This condition increases the need for medical care and is associated with mental health disturbances, reduced quality of life, and social isolation.[3,4]

Several instruments can be used to assess functional capacity, such as the Karnofsky Performance Scale (KPS) and the Chelsea Critical Care Physical Assessment Tool (CPAx). However, these instruments are less sensitive to changes in critically ill patients and are not specific to burn patients. The Functional Assessment for Burns–Critical Care (FAB-CC) was specifically developed for burn patients in intensive care settings, focusing on simple functional tasks and offering greater sensitivity to changes in functional capacity among critically ill burn patients.[5] Optimal nutritional support, with adequate energy and protein intake, can improve functional capacity by supporting wound healing, preventing muscle mass loss, and enhancing mobility and independence.[6]

Daily caloric and protein intake must be carefully monitored to preserve muscle mass and potentially improve functional capacity.[7,8] However, there are limited data describing early energy and protein provision and its impact on functional capacity assessed using FAB-CC in burn patients. Therefore, we present this case series to illustrate the role of energy and protein provision in improving functional capacity as assessed by FAB-CC.

Case report

Case 1

Clinical findings

A 39-year-old male was admitted with burns involving the face, chest, back, and both upper and lower extremities, which had occurred 2 days prior to hospitalization. The injury was caused by flame burns originating from cigarette ash sparks. The patient had no known comorbidities. On examination, he was found to have class II obesity with a body mass index (BMI) of 34.8 kg/m². Burn severity was classified as grade 2A–3, involving 35.5% of total body surface area (TBSA).

Before admission, the patient had received fluid resuscitation with 0.9% NaCl 2,000 mL/24 hours. During hospitalization, inflammatory parameters worsened, as shown by increases in C-reactive protein (CRP) and neutrophil-to-lymphocyte ratio (NLR). Electrolyte abnormalities were also noted, including hyponatremia (sodium 128.8 mmol/L) and hyperkalemia (potassium 5.2 mmol/L). The patient also developed hypoalbuminemia requiring correction

Nutritional assessment

At admission, nutritional screening using the Nutritional Risk Screening 2002 (NRS-2002) yielded a score of 3, indicating a risk of malnutrition. Despite pre-existing obesity, the patient remained at nutritional risk due to extensive burns and hypermetabolic stress. At admission, the patient's body weight was 85 kg based on anamnesis, whereas the initial bed-scale measurement was 91.2 kg. During follow-up, bed-scale body weight decreased to 84.5 kg on post-burn day 19 (hospital day 16) and 84.3 kg on post-burn day 20 (hospital day 17). This corresponded to a 1.7 kg (2.0%) reduction in body weight over the final 4 days of hospitalization. Functional capacity at baseline was poor, with an initial FAB-CC score of 3.

Intervention

Nutritional therapy was initiated at 10 kcal/kg/day with protein 1 g/kg/day, then gradually advanced according to clinical condition and tolerance, reaching energy total requirement by Xie equation around 42 kcal/kg/day and 1.99 g/kg/day of protein. Energy and protein intake decreased during the period of excisional debridement. Nutritional intervention was provided via the oral route using solid foods and hospital-based high-protein oral nutritional supplements in liquids form. Supportive correction for metabolic and electrolyte imbalance included NaCl capsules 1,000 mg, three times daily for hyponatremia, Kalitake® 5 g, three times daily for hyperkalemia, and 20% albumin IV 100 mL, administered three times for hypoalbuminemia.

Outcome

Functional capacity improved progressively during hospitalization, with the FAB-CC score increasing from 3 at admission to nearly 30 by day 17. Over the nutritional intervention, the patient demonstrated an improvement in functional capacity in parallel with increased energy and protein intake. When energy intake increased to 33 ± 0.8 kcal/kg body weight/day and protein intake to 1.5 ± 0.1 g/kg body weight/day, the patient's total FAB-CC score increased to 30—the highest score achieved during hospitalization—on nutrition days 14 to 17. At discharge, the patient had a FAB-CC score of 30, indicating the ability to stand, step, and perform activities independently.

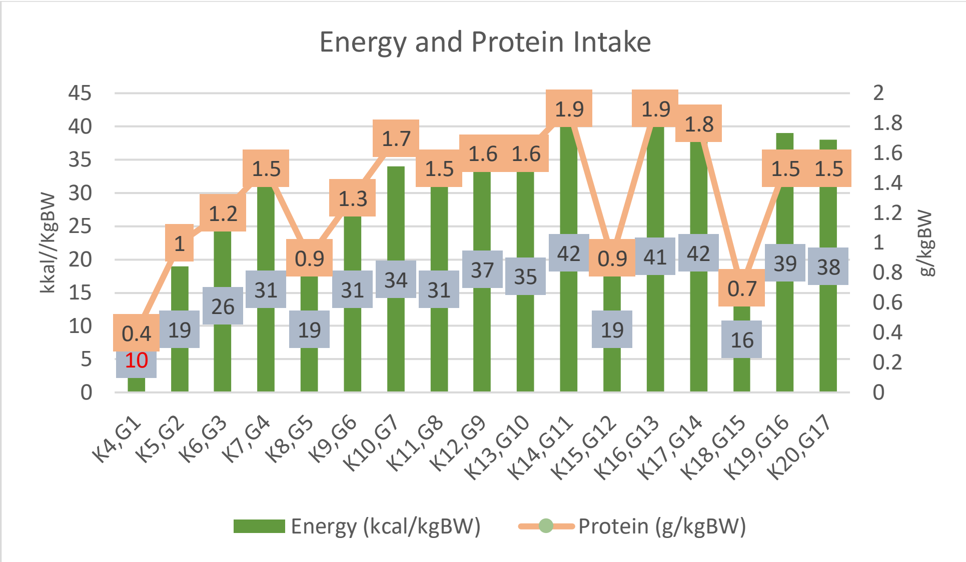

Figure 1. Energy and protein intake in case 1 during the observation period.
(K: post burn injury day; G: nutrition day)

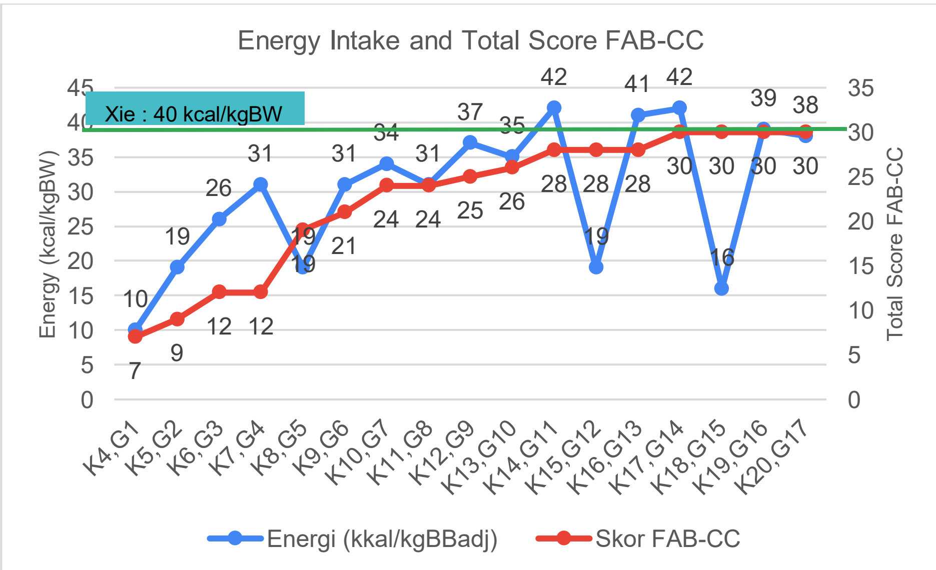

Figure 2. Energy intake pattern and total score FAB-CC during observation.
(K: post burn injury day; G: nutrition day)

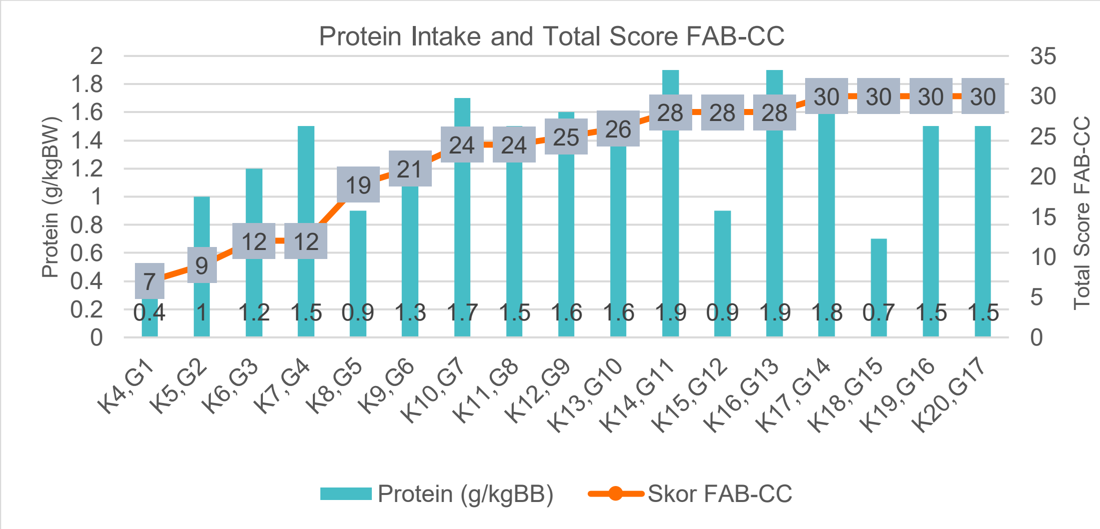

Figure 3. Protein intake pattern and total score FAB-CC during observation.
(K: post burn injury day; G: nutrition day)

Case 2

Clinical findings

A 35-year-old male was admitted with burns involving the face, back, genitalia, and both upper and lower extremities, which had occurred 3 days prior to admission. The injury was caused by hot water scalding while riding a motorcycle. On admission, the patient had no known comorbidities. Burn severity was classified as grade 2A–3, with a total burn area of 57.5% TBSA. Initial management included fluid resuscitation with Ringer's lactate. During hospitalization, inflammatory markers showed mixed trends: the neutrophil-to-lymphocyte ratio (NLR) decreased from 35.13 to 25.67, whereas procalcitonin increased from 1.3 ng/mL to 5.73 ng/mL. The clinical course was further complicated by septic shock and pan-drug-resistant infection, requiring admission to the intensive care unit for 3 days and mechanical ventilation for 2 days.

Nutritional assessment

At baseline, the patient was nutritionally normal, with a body mass index (BMI) of 21.7 kg/m². However, nutritional risk screening using NRS-2002 yielded a score of 3, indicating risk of malnutrition. During the 28-day monitoring period, body weight decreased from 55.7 kg to 51.5 kg. There was a 4.2 kg (8%) weight loss over 28 days, accompanied by energy intake below 75% of total estimated requirements during the last 3 weeks. Weight loss in Case 2 was greater than in Case 1, likely due to septic shock and pan-drug-resistant infection, which were associated with fever and reduced oral intake. Functional capacity on admission was poor, with an initial FAB-CC score of 3.

Intervention

Nutritional therapy was initiated conservatively at 10 kcal/kg/day with protein provision of 0.4 g/kg/day. Intake was then gradually advanced according to clinical tolerance and metabolic demands, reaching 60 kcal/kg/day and 2.5 g/kg/day of protein, as shown in

Figure 1. In parallel with medical and critical care management, the patient also underwent intensive monitoring of nutritional intake, body weight, and functional capacity throughout hospitalization.

Outcome

Nutritional intake increased progressively from 10–30 kcal/kg/day and 0.4–1.4 g/kg/day of protein in the early phase to 51–60 kcal/kg/day and 2.4–2.5 g/kg/day of protein at peak intake. This improvement in nutritional adequacy was accompanied by a parallel improvement in functional capacity, with the FAB-CC score increasing from 3 at admission to 23, reflecting better bed mobility, independent sitting, standing with minimal assistance, and self-care ability. However, this improvement was interrupted by septic shock, which led to a decline in functional status and necessitated ICU care. After recovery from the critical episode, the patient's functional capacity improved again, reaching a FAB-CC score of 20 by the end of hospitalization. The association between the patient's energy and protein intake profile and the improvement in functional capacity, as measured by the FAB-CC, is presented in **Figure 2** and **Figure 3**. Compared with Case 1, Case 2 demonstrated greater weight loss and lower FAB-CC scores, likely related to septic shock and pan-drug-resistant infection. The patient was discharged after 31 days of hospitalization with a final FAB-CC score of 20.

Discussion

Burn injuries are conditions that can lead to a significant decline in functional capacity among survivors.[9,10] Extensive tissue damage triggers both local and systemic inflammatory responses. Burns induce a hypermetabolic state in which the body's metabolic rate markedly increases to support tissue repair processes and to maintain vital organ function.[3,4,11]

Hypermetabolism in burn patients is characterized by increased energy requirements and alterations in carbohydrate, protein, and fat metabolism. The body increases gluconeogenesis and lipolysis to meet heightened energy demands, while insulin resistance may result in hyperglycemia. A major consequence of this hypermetabolic state is excessive protein catabolism, whereby skeletal muscle proteins are broken down to provide amino acids as substrates for gluconeogenesis and for the synthesis of acute-phase proteins, such as C-reactive protein (CRP). This hypermetabolic and hypercatabolic response may persist for months to years after the burn injury, with severity influenced by factors such as burn size, patient age, and pre-burn nutritional status. Consequently, burn patients may experience substantial loss of muscle mass, ultimately impairing functional capacity.[3,12,13] Therefore, comprehensive patient assessment, including evaluation of functional capacity, is essential because it is closely related to management strategies and prognosis.[4,14] Burn size is directly associated with the severity of hypermetabolism; energy requirements may increase up to 1.5–2 times the basal energy expenditure due to activation of the sympathetic nervous system, stress hormones, and systemic inflammatory responses. This condition is accompanied by massive nitrogen losses, increased protein turnover, and reductions in muscle mass of up to 15–20% within the first week if not managed adequately.[7,14]

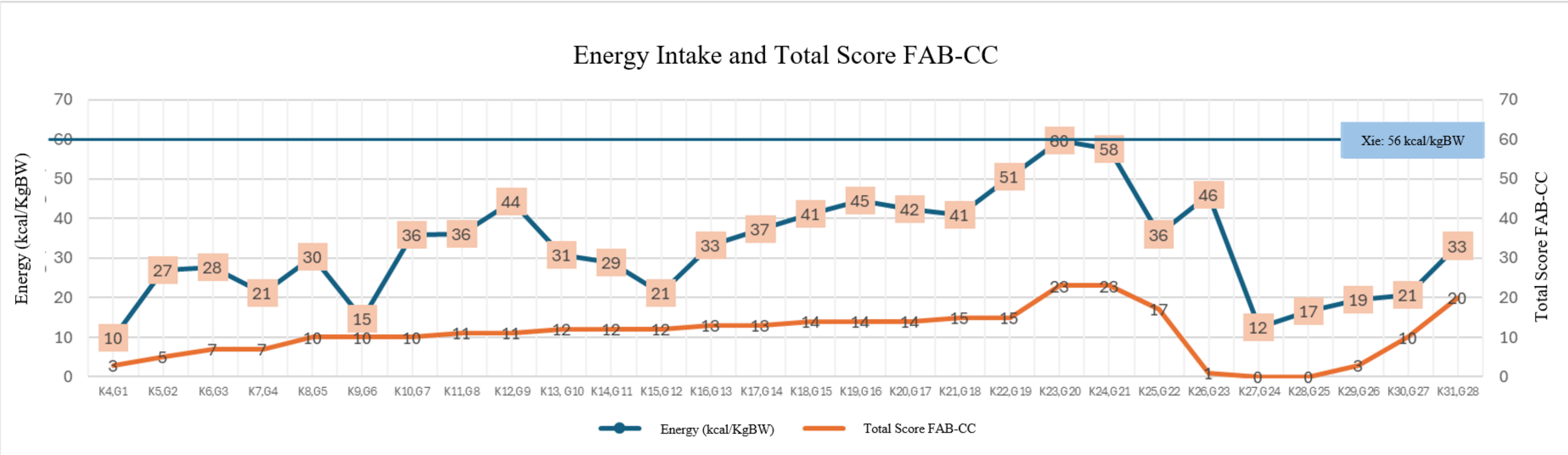

Figure 4. Energy intake and Total Score FAB-CC. (K: post burn injury day; G: nutrition day)

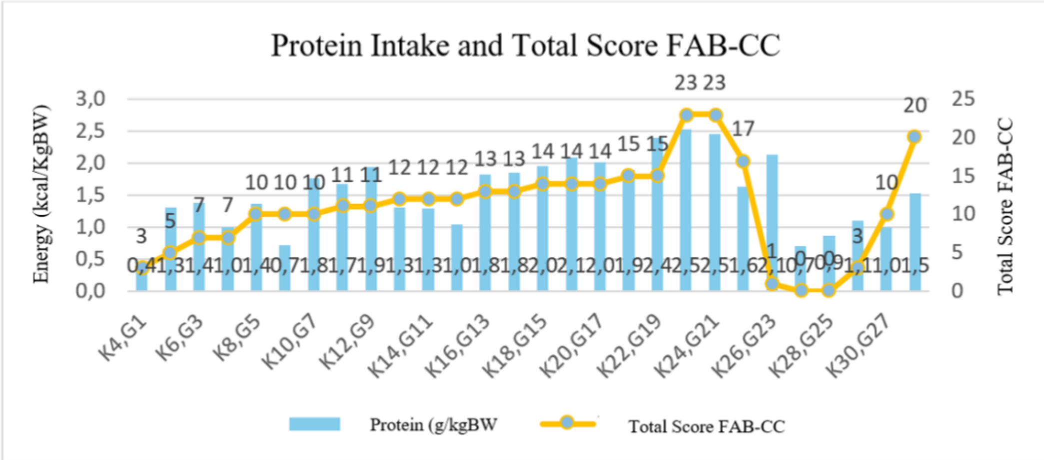

Figure 5. Protein intake and total score FAB-CC. (K: post burn injury day; G: nutrition day)

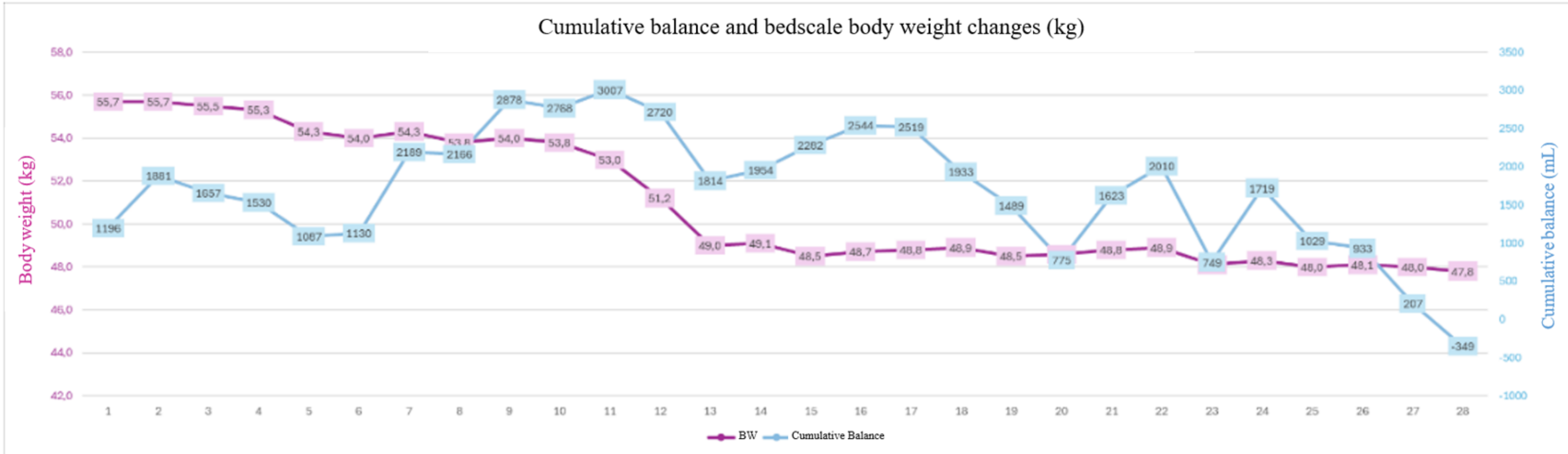

Figure 6. Bedscale body weight changes and cumulative balance observation. (K: post burn injury day; G: nutrition day)

The clinical characteristics and laboratory findings of each case are comprehensively summarized in Tables 1 and 2

Table 1. Characteristic of the case

Charateristic	Case 1	Case 2
Gender	Male	Male
Age	39 year old	35 year old
Etiology	Flame	Hot Water
Total Body Surface Area	35,5%	57,5%
Burnt depth	2A–3	2A–3
Time of Event	4 days prior to admission	3 days prior to admission
History of resuscitation	Achieved within 24 hours	Achieved within 24 hours
Urine output	0,8 mL/kgBW/hour	1,4 mL/kgBW/hour
Nutritional screening (NRS 2002)	Score 3 (At risk of malnutrition)	Score 3 (At risk of malnutrition)
Nutritional Status		
Body weight by history	86 kg	52 kg
Height	157 cm	160 cm
BMI	34.8 kg/m²	21.7 kg/m²
Interpretation	Class II obesity	Normal body weight
Final nutritional status at discharge	Class II obesity	Moderate malnutrition
Energy requirement based on Xie	2565 kkal (40 kcal/kg adjusted body weight)	2958 kkal (56 kcal/kg body weight)
Average intake during monitoring		
Energy (kcal)	1924	1644
Energy (kcal/kg body weight)	30	33
Protein (g/kg body weight)	1.3	1.5
Average bed-scale body weight during monitoring (kg)	88.5	51.1
Average total FAB-CC score	23	11
Excisional debridement to STSG procedures	3 times	3 times
Length of stay	18 days	29 days
Complications	None	Pan drug resistant infection, septic shock, step-up to ICU, bilateral plantar flexion contractures

Table 2. Laboratorium findings

	Case 1	Case 2
Hemoglobin (g/dL)	11,1 (9,6-18,6)[a]	10,5 (9,2-15,7)[a]
NLR	3,88 (1,17-3,97)[a]	18,6 (7,3-46,14)[a]
PCT (ng/mL)	13,5	3,9 (0,2-1,7)[a]
Albumin (g/dL)	2,39 (2,28-2,67)[a]	2,2 (1,75-2,6)[a]
Laktat (mmol/L)	4	3,5 (1,8-20,3)[a]

NLR: *Neutrophil to Lymphocyte Ratio*; PCT: Prokalsitonin, [a]median (minimum–maximum)

The Functional Assessment for Burns–Critical Care (FAB-CC) is an instrument used to assess functional capacity with good diagnostic performance.[12,15] In addition to hypermetabolism, systemic inflammatory responses in burn injuries also contribute to muscle breakdown through increased levels of cortisol and glucagon.[11,16] In both cases presented, inflammatory responses were evident, as indicated by elevated laboratory parameters such as the neutrophil-to-lymphocyte ratio (NLR), procalcitonin, and C-reactive protein (CRP).

All patients demonstrated increases in daily energy and protein intake, which were associated with improvements in FAB-CC scores and functional capacity. For example, in Case 1, energy intake increased from 10 kcal/kg adjusted body weight to 42 kcal/kg adjusted body weight, and protein intake increased from 0.9 g/kg adjusted body weight to 1.9 g/kg adjusted body weight, concomitant with an improvement in the total FAB-CC score from 7 to 30 (full independence). In Case 2, progressive increases in energy intake (from 10 kcal/kg body weight to a peak of 60 kcal/kg body weight) and protein intake (from 0.4 g/kg body weight to 2.5 g/kg body weight) were accompanied by an increase in the total FAB-CC score from 3 to a maximum of 23. A total FAB-CC score of 23 indicates that the patient was not yet fully independent but had achieved relatively good physical function and was above the threshold for high risk of dependency (≥10).

All patients showed improvement in total FAB-CC scores in parallel with increasing daily nutritional intake, despite worsening inflammation, indicating the important role of adequate daily energy and protein intake in maintaining and improving functional capacity in burn injury patients. Nevertheless, factors beyond nutritional intake also influence recovery. Improvement in functional capacity in burn injury patients is determined by the interaction of patient-related factors (advanced age, sex, comorbidities, baseline nutritional status), burn injury severity and distribution, the clinical course in the intensive care unit, adequacy of energy and protein intake to prevent muscle loss, and the intensity and timing of physical rehabilitation programs. In addition, psychological factors and social support, including access to rehabilitation services, play a major role in the successful recovery of function and independence.[17,18]

The administration of high-protein formulas in burn patients is a crucial component of care to optimize healing and improve clinical outcomes. Burns cause significant metabolic stress, leading to increased protein catabolism, loss of muscle mass, and impaired immune function. High-protein formulas supply essential amino acids required for protein synthesis, support tissue repair, preserve muscle mass, and enhance immune function. Adequate protein intake has been shown to accelerate wound healing, reduce infectious complications, and shorten hospital length of stay in burn patients. Therefore, high-protein nutritional support represents an important nutritional intervention that contributes to recovery and rehabilitation in burn patients.[19,20]

A systematic review by Hampton et al. demonstrated that energy intake of 30–35 kcal/kg body weight combined with protein intake of 1.3–1.5 g/kg body weight significantly improved functional capacity, particularly muscle strength, in patients with severe burns. These findings have important practical implications for clinical practice, especially in the nutritional management of burn patients.[20,21] Energy provision of 25–48 kcal/kg body weight and protein intake of 1.2–2.2 g/kg body weight, as applied in both cases, may be considered as part of a care strategy to enhance functional capacity. Appropriate nutritional support can facilitate wound healing, prevent muscle mass loss, and improve patients' quality of life. Further studies are required to confirm these findings.

Study limitations

This study is limited by the absence of a control group and the lack of statistical analysis examining the association between energy and protein intake and functional recovery.

Interpretation of the findings is further constrained by important confounders, including sepsis, repeated debridement, and duration of ICU stay, all of which may affect both nutritional intake and functional outcomes. Further prospective studies with more rigorous methodology are needed to define the independent contribution of nutritional adequacy to functional improvement in patients with burn injury.

Conclusion

In conclusion, observations from both cases suggest that adequate energy and protein intake during nutritional care may contribute to improved functional capacity in patients with burn injuries. Across the observation period, mean energy intake of 30–33 kcal/kg/day and protein intake of 1.3–1.5 g/kg/day were accompanied by progressive improvement in functional status, as reflected by increases in FAB-CC scores from 0 to 23–30. However, this improvement in functional capacity cannot be attributed solely to increased energy and protein intake. It was also likely influenced by multidisciplinary management, including debridement performed by the plastic surgery team, infection control by the plastic surgery and infectious and tropical disease teams, adequate and regular rehabilitation provided by the rehabilitation medicine team, and supportive care from nursing staff and psychiatry in assisting the patient with daily activities. Although these findings should be interpreted cautiously given the descriptive nature of the report and the presence of clinical confounders, they support the potential importance of nutritional adequacy as part of a comprehensive multidisciplinary approach to promote functional recovery in burn patients.

Conflict of interest

The authors declared no conflict of interest regarding this article.

Author Contributions

MK, WS, ANF: Conceptualization, data acquisition, formal analysis, interpretation of results, drafting the manuscript, and final approval of the version to be published; WS, AW, ANF: Supervision, critical revision of the manuscript, interpretation of data, and final approval of the version to be published; MK,WS: Conception and design of the study, critical revision of the manuscript for important intellectual content, and final approval of the version to be published.

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