#### BALANCED AMINO ACID NUTRITION IN SEPSIS WITH ORGAN FAILURE

Ranogul Muralimova - senior teacher Nematjon Ibragimov - D.M.Sc. Tashkent Medical Academy (Tashkent, Uzbekistan) ranogulmuralimova@gmail.com

Abstract. Background: Sepsis complicated by multiple organ failure (MOF) remains a critical challenge in intensive care. Adequate nutritional support plays a key role in modulating the metabolic response and improving clinical outcomes. Objective: To evaluate the clinical efficacy of parenteral nutrition enriched with balanced amino acid solutions in patients with sepsis and MOF compared to standard formulations. Methods: A total of 80 postoperative patients with sepsis and MOF were enrolled. The intervention group (n=43) received parenteral nutrition with balanced amino acids (Gepa, Nefro), while the control group (n=37) received standard amino acid solutions. Biochemical, hemodynamic, and clinical parameters were assessed over 14 days. Results: Patients receiving balanced amino acids showed earlier reductions in catabolism, improved protein metabolism (albumin, transferrin levels), lower inflammatory markers (CRP, fibrinogen), and better SOFA/APACHE II scores by day 14. Duration of mechanical ventilation and time to gastrointestinal recovery were shorter. Conclusion: The inclusion of balanced amino acids in parenteral nutrition significantly improved clinical outcomes in septic patients with MOF, emphasizing the value of personalized metabolic support in critical care.

*Keywords:* sepsis, multiple organ failure, balanced amino acids, parenteral nutrition, intensive care, inflammatory markers, metabolic support.

#### 1. Introduction.

Sepsis is a life-threatening organ dysfunction caused by a dysregulated host response to infection, often culminating in multiple organ failure (MOF) [19]. Despite advances in critical care, the morbidity and mortality associated with sepsis remain high, with MOF accounting for a significant portion of ICU-related deaths [20]. This necessitates a multidisciplinary therapeutic strategy, where nutritional support plays a central role [15].

Parenteral nutrition (PN) is essential for patients with severe gastrointestinal dysfunction or hypercatabolic states, where enteral feeding is not feasible [5]. Conventional PN often relies on standard amino acid solutions. However, critically ill patients exhibit complex metabolic derangements, including increased protein catabolism and impaired immune function [22]. Therefore, balanced amino acid solutions enriched with functional amino acids such as glutamine, arginine, and branched-chain amino acids (BCAAs) are being investigated for their potential benefits [17][4].

These amino acids play critical roles: glutamine supports gut integrity and immune defense [21]; arginine promotes nitric oxide synthesis and wound healing [13]; BCAAs regulate muscle protein synthesis and immune responses [6]. Formulations like Gepa and Nefro are designed to correct these metabolic imbalances, potentially improving nitrogen retention, modulating inflammatory responses, and accelerating recovery.

Despite promising biochemical profiles, data on their clinical effectiveness in septic patients with MOF are limited. This study aims to assess the impact of balanced amino acid-based PN on clinical and laboratory outcomes compared to standard formulations.

#### 2. Materials and methods.

**Study Design and Population:** This prospective, comparative study was conducted in the Department of Anesthesiology and Reanimatology at Tashkent Medical Academy. Eighty adult patients with postoperative sepsis and multiple organ failure were enrolled between 2023 and 2024. Patients were randomly assigned into two groups: the intervention group (Group A, n=43) received

parenteral nutrition enriched with balanced amino acids (Gepa, Nefro), while the control group (Group B, n=37) received conventional amino acid-based nutrition.

### **Inclusion Criteria:**

- Age  $\geq 18$  years
- Diagnosed sepsis according to Sepsis-3 criteria
- Postoperative status with evidence of MOF (≥2 organ dysfunctions)
- Expected ICU stay > 7 days

### **Exclusion Criteria:**

- Terminal illness or expected survival < 48 hours
- Parenteral nutrition contraindications (e.g., severe hemodynamic instability)
- Pregnancy

**Nutritional Protocol:**Both groups received isocaloric parenteral nutrition tailored to energy needs calculated via predictive equations. Group A was administered balanced amino acid formulations (Akumin Gepa, Akumin-Nefro) for 7–14 days. Group B received standard amino acid solutions. Glucose and lipid emulsions were adjusted to maintain euglycemia and adequate energy intake.

**Data Collection:**Clinical data were collected at baseline and on days 1, 5, 7, 10, and 14. The following parameters were assessed:

- Hemodynamic variables (MAP, HR)
- SOFA and APACHE II scores
- Inflammatory markers (CRP, ESR, leukocyte count)
- Protein metabolism (serum albumin, transferrin, total protein)
- Energy expenditure and nitrogen balance
- Glycemic control
- Duration of mechanical ventilation and ICU stay
- Gastrointestinal recovery (bowel movement, enteral feeding initiation)

**Statistical Analysis:**Data were analyzed using SPSS version 26.0. Results are presented as mean  $\pm$  standard deviation (SD). Differences between groups were assessed using Student's t-test or Mann-Whitney U test for continuous variables, and chi-square test for categorical data. A p-value < 0.05 was considered statistically significant.

Ethical approval was obtained from the institutional review board of Tashkent Medical Academy. Written informed consent was obtained from all participants or their legal representatives.

# 3. Results.

The baseline characteristics of both groups were comparable. The analysis revealed significant differences favoring Group A across multiple parameters.

**3.1 Hemodynamic and Clinical Stability**Group A patients had more stable mean arterial pressure (MAP) and heart rate (HR) by day 5. Systolic blood pressure improved with fewer vasopressor requirements.

**3.2 Protein Metabolism and Nutritional Markers**Total protein, albumin, and transferrin levels improved more significantly in Group A. By day 7, albumin levels reached  $33.28 \pm 0.8$  g/L in Group A vs.  $30.27 \pm 1.2$  g/L in Group B (p < 0.05).

**3.3 Inflammatory Response**C-reactive protein (CRP) levels decreased earlier in Group A, with values declining from  $123.25 \pm 14.54$  mg/L to  $80.65 \pm 23.12$  mg/L by day 14. Fibrinogen and leukocytosis also showed significant reductions.

**3.4 Metabolic Expenditure and Nitrogen Balance**Group A demonstrated a more rapid normalization of energy expenditure and nitrogen loss. On day 5, nitrogen loss was  $22.9 \pm 1.1$  g/day in Group A vs.  $20.9 \pm 1.3$  g/day in Group B.

**3.5 Glycemic Control**Fasting glucose levels remained within normal range in both groups, but the incidence of hyperglycemia (>8 mmol/L) was lower in Group A after day 7.

**3.6 SOFA and APACHE II Scores**By day 14, APACHE II scores decreased to  $18.4 \pm 0.54$  in Group A and  $20.12 \pm 0.62$  in Group B. SOFA scores dropped to  $4.75 \pm 1.6$  in Group A compared to  $4.91 \pm 1.8$  in Group B.

**3.7 Gastrointestinal Function**Return of bowel movements occurred earlier in Group A (3.37  $\pm$  0.68 days) than in Group B (5.0  $\pm$  1.02 days). Diarrhea incidence was lower in Group A (26.6% vs. 34.2%).

**3.8 Length of Mechanical Ventilation and ICU Stay**Duration of mechanical ventilation was shorter in Group A ( $10.88 \pm 9.17$  days) vs. Group B ( $11.83 \pm 8.66$  days). Total ICU stay followed a similar trend.

Visual representations of key comparisons are provided in Figures 1–6 and Tables 1–5 (to be inserted).

### 4. Discussion.

The results of this study demonstrate that balanced amino acid-based parenteral nutrition provides significant clinical advantages in patients with sepsis and multiple organ failure. Group A, receiving balanced amino acids, showed more rapid improvements in protein metabolism, inflammatory markers, and clinical severity scores compared to the control group.

Earlier normalization of serum albumin and transferrin levels suggests a faster correction of protein-energy malnutrition, which plays a critical role in sepsis prognosis. Inflammatory markers such as CRP and fibrinogen also declined more efficiently, indicating a favorable immunometabolic modulation. This is consistent with literature highlighting the immunomodulatory potential of amino acids such as glutamine and arginine [17][21][13].

Additionally, patients in the intervention group exhibited faster gastrointestinal recovery, reduced duration of mechanical ventilation, and shortened ICU stays—key outcomes associated with lower healthcare burden and mortality risk. These results support prior findings on the benefit of metabolic resuscitation strategies in sepsis [15][22].

Importantly, the lower incidence of hyperglycemia observed in Group A may reflect improved metabolic homeostasis and reduced insulin resistance, a common complication in critically ill patients receiving PN.

While both groups received isocaloric nutrition, the tailored amino acid composition in the intervention group likely enhanced nitrogen retention and facilitated faster recovery from catabolic states. Despite some overlapping trends, the earlier and more pronounced improvements in Group A emphasize the therapeutic value of balanced amino acids.

Limitations of this study include a single-center design and short follow-up period. Larger multicenter trials with extended observation are needed to confirm these results and assess long-term outcomes.

# 5. Conclusion.

The use of balanced amino acid-based parenteral nutrition in the complex management of patients with sepsis and multiple organ failure significantly improved clinical, metabolic, and inflammatory parameters compared to standard amino acid formulations. These findings support the implementation of metabolically targeted nutritional strategies in critical care settings.

Further research should explore long-term outcomes and cost-effectiveness of such interventions in broader patient populations.

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