# Nutritional status in intensive care unit patients: a prospective clinical cohort pilot study

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ORIGINAL ARTICLE

# Nutritional status in intensive care unit patients: a prospective clinical cohort pilot study

**Mohsen Nematy · Seyed Amir Reza Mohajeri · Shirin Amiri Moghadam · Mohammad Safarian · Abdolreza Norouzy · Seyed Mohammad Reza Parizadeh · Mahmoud Reza Azarpazhooh · Zahra Siadat · Nasim Shahsavan Gharbi · Majid Ghayour Mobarhan**

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**Abstract** Previous researches have shown that the nutritional status of patients in the intensive care unit (ICU) was poor on admission and appears to decline during their stay in the ICU. Critically ill patients are prone to malnutrition because their hypermetabolic disorders lead to an increase in nutritional requirements that are not often met with the nutrition supplied. The aim of this study was to assess the nutritional status and hs-CRP of ICU patients on admission and discharge from the hospital. Twenty-nine neurological ICU patients (20–87 years old) underwent fasting blood sample collections, anthropometric measurements and impedance analysis on admission and discharge at Ghaem Teaching Hospital. NRS 2002 was used to determine malnutrition in ICU patients. Markers of nutritional status changed from admission into the ICU until discharge as follows: weight, BMI and triceps skinfold thickness decreased ($p < 0.001$, $p < 0.001$ and $p < 0.005$, respectively). hs-CRP was decreased over the stay in the hospital (admission = 19.4 ± 16.3, discharge = 13.8 ± 14.5, $p$ value = 0.11). The percent of patients at risk of malnutrition decreased during stay in ICU (not significant). Prevalence of malnutrition was as high as 47.6% on admission. The nutritional status of patients was slightly improved over the period of their stay in hospital using NRS 2002 method.

**Keywords** Intensive care unit · NRS 2002 · hs-CRP

**Abbreviations**

| | |
|---|---|
| BMI | Body mass index |
| hs-CRP | High sensitive C-reactive protein |
| ICU | Intensive therapy unit/intensive care unit |
| SEM | Standard error of the mean |

M. Nematy · M. Safarian · A. Norouzy · M. G. Mobarhan
School of Medicine, Biochemistry and Nutrition Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

M. Nematy (✉) · S. A. R. Mohajeri · S. A. Moghadam · M. Safarian · A. Norouzy · Z. Siadat · N. S. Gharbi · M. G. Mobarhan
Nutrition Department, School of Medicine, Mashhad University of Medical Sciences (MUMS), Ferdowsi Pardis, Azadi Square, PO Box 91775-379, 91779-48564 Mashhad, Iran
e-mail: NematyM@mums.ac.ir; M.Nematy02@imperial.ac.uk

S. M. R. Parizadeh
Biochemistry Department, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

M. R. Azarpazhooh
Neurology Department, School of Medicine, Qaem Hospital, Mashhad University of Medical Sciences, Mashhad, Iran

## Introduction

Research suggested that 10–40% of adult patients admitted to hospital exhibited some level of nutritional depletion [1], with further weight loss, occurring over the period of hospitalization [2]. In a study of 156 patients, the prevalence of malnutrition was increased from 12.9% on admission to 23.1% on discharge in Iran [3]. A recent study using Nutritional Risk Screening 2002 method showed that the overall prevalence of nutritional risk changed from 27.3 to 31.9%, and the prevalence of undernutrition changed from 9.2 to 11.7% during hospitalization in Beijing Teaching hospitals, China [4].

This is a matter of particular concern for certain categories of hospitalized patients, e.g., those in intensive care units (ICUs) who are a vulnerable group. A report by Giner showed that 55 out of 129 patients admitted to ICUs were already suffering from malnutrition [5]. Their nutritional status further declined during the intensive care and also after their ICU stay [5]. Research show that despite more than 20 years of intense awareness, malnutrition is still highly prevalent in hospitalized patients and this continues to affect patients' outcomes [5]. Malnutrition has serious consequences for recovery and increases the risk of complications in hospitalized patients [6]. Malnutrition and low muscle mass reduce the ability of patients to fight critical illness. The critically ill patient is especially susceptible to malnutrition due to his/her hyper metabolic state that leads to an increase in the nutritional requirements [7]. It is estimated that the incidence of malnutrition in intensive care patients could be as high as 50% [8, 9].

The mechanism of poor nutritional intake and weight loss in intensive care patients remains unclear, but gastrointestinal hypomotility with delayed gastric emptying may be contributing factors. Impaired appetite is a common feature of illness [10]. A recent review suggested that the combination of stress and undernutrition observed in the ICUs is associated with negative energy balance, which leads to lean body mass loss [11]. Catabolism of lean body mass has been repeatedly associated with a worsening of the clinical outcome, increased length of hospital stay, recovery and healthcare costs [11]. In recent years, nutritional supplements are used in most hospitals, but their effectiveness varies, probably due to the influence of poor appetite [12].

Findings from Imperial college's metabolic medicine lab suggested that peptide hormones released from the gut, such as ghrelin and peptide YY (PYY), which stimulate and inhibit the appetite, respectively [13, 14], might play a role in the altered eating behavior of patients [6, 15], particularly intensive care patients [16] because the anorexia in hospitalized patients is often characterized by a premature feeling of fullness and loss of hunger.

It is suggested that supplemental parenteral nutrition, together with sufficient enteral nutrition, could optimize the nutritional therapy by preventing the onset of early energy deficiency, and thus, could allow reducing the side-effects of undernutrition and promote better chances of recovery after the ICU stay [11].

The nutritional status of intensive care patients in Razavi Khorasan province is not known. The aim of this study is to evaluate the nutritional status and hs-CRP of ICU patients on admission and discharge.

## Materials and methods

### Study subjects

This was a prospective cohort pilot study undertaken at the Neurologic Intensive Care Unit at Ghaem Teaching Hospital, Mashhad, Iran. Local ethics committee approval was obtained for the enrollment of patients. Patients with adequate mental capacity gave written informed consent prior to enrollment; for others, a close relative/partner gave written assent. Patient refusal at any time resulted in complete withdrawal from the study.

The inclusion criteria were male and female patients between the ages of 20 and 85 years who were anticipated to stay in the ICU for longer than 1 week in the opinion of the neurologist consultant. Exclusion criteria were patients who were anticipated to die, or stay less than 1 week in the ICU; those who were known to be HIV or hepatitis B surface antigen positive. The study was performed in accordance with the Declaration of Helsinki.

### ICU patients

Nutritional and medical data were collected from patients, charts, medical notes, dieticians and medical teams. Patients were followed up clinically until discharge from the ICU or death.

### Food intake

One day food intake was estimated from food record charts completed on admission and on discharge from the ICU. The nutritional content of the patients' food record charts was calculated using computerized food tables in Food Analyser software (2008, Salek Teb co., Iran).

### Anthropometric measurements

Anthropometric indices, including weight, height and triceps skinfold thickness were assessed on admission and on discharge from the ICU [17]. Patients' weights were measured by bed-scale (Seca 984, Germany); by connecting four leads to their bed when they were laid on the bed. The demi-span was measured to calculate the height to compute body mass index (BMI) [18].

### Bio impedance analysis (BIA)

Body composition analysis was performed by portable bio Impedance analyzer (Body stat 1500 MDD, England) on admission and discharge. BIA measurements were done at 8 a.m. in all patients in order to have similar situation. BIA is one of the newest technologies for measuring body composition. Researches showed that this may help in critical care units [19]. Body fat, lean body mass and body water indices were used for analysis.

Blood sampling

Fasting blood samples (10 ml each time) were taken on admission and on the nearest date to the discharge home. In the ICU, fasting blood samples were taken at 6.30 a.m. at the same time with other sampling, before starting breakfast for those on oral feeding. Blood samples were centrifuged at 4 °C; plasma was then separated, frozen immediately and stored at −20 °C until analysis.

Biochemical indices

Stored frozen plasma samples were used to measure pre-albumin, albumin, total protein, and hs-CRP.

Nutritional risk screening (NRS 2002)

In this study NRS 2002 method, a system for screening of nutritional risk was used to assess malnutrition [20]. This method is based on the concept that nutritional support is indicated in patients who are severely ill with increased nutritional requirements, or who are severely undernourished, or who have certain degrees of severity of disease in combination with certain degrees of undernutrition [21]. Patients were scored in each of the two components; undernutrition and disease severity, according to whether they were absent, mild, moderate or severe, giving a total score of 0–6. If patient was more than 70 years, one point was added to the total score. Patients with a total score of ≥3 were classified as nutritionally at risk. Undernutrition was estimated using three variables in most screening tools: BMI, percent recent weight loss and change in food intake, since these have reasonable evidence base in the literature, correlating with changes in function and clinical outcome [21].

Statistical analysis

The data were analysed using SPSS 15 for windows (SPSS Science, Apache Software Foundation, Chicago, IL, USA). All data were checked for normality and presented as mean ± standard error of the mean (SEM). Descriptive statistics and compare means (Independent sample *t* test and Paired sample *t* test) were also used.

A Paired sample *t* test was performed to compare the variables between admission and discharge.

## Results

Two hundred and thirty-six patients were approached to take part in the study. Of these, 74 patients were recruited; eight patients were confused and or unable to give informed consent. Sixty-six patients were eligible for the study. Sample size was reduced to 29 for further statistics as researcher lost discharge date or patients were referred to other hospitals.

Demographics of patients

Demographics of patients and their anthropometrics are displayed in Table 1. Method of feeding in the ICU, energy intake after admission, length of stay in the ICU and diagnosis are presented in appendix Table 3. Patients were on oral ($N = 11$, 37.9%) and enteral feeding ($N = 18$, 62.1%). Length of stay in the ICU was an average 17.9 day (±10.4). The five top reasons that patients were admitted to the intensive care were Myasthenia ($N = 6$, 20.7%), Thrombosis and sinusoidal thrombosis ($N = 6$, 20.7%), Cerebrovascular accident (CVA) ($N = 4$, 13.8%), Convulsion ($N = 3$, 10.3%) and Subarachnoid hemorrhage (SAH) ($N = 3$, 10.3%).

Markers of nutritional status

Table 2 shows changes in anthropometrics, BMI, bio impedance analysis variables, biochemical indices and food intakes between admission and discharge.

Markers of nutritional status consisting of weight, triceps skinfold thickness, and BMI decreased during the stay (from admission into the ICU until discharge). On entering the ICU, patients had significantly lower pre-albumin and total protein than discharge.

NRS 2002

Malnutrition decreased during stay of ICU patients in hospital using NRS 2002 method (Table 2).

**Table 1** Demographics of 29 intensive care unit patients of Ghaem hospital in Mashad

| | ICU[a] patients Percentage | Control group Percentage |
|---|---|---|
| Gender | | |
| Male | 44.8% | 82.4% |
| Ethnic group | | |
| Asian | 100% | 100% |
| | Mean ± SEM[b] | Mean ± SEM |
| Age (years) | 46.4 ± 17.7 | 42.3 ± 2.0 |
| Anthropometric | | |
| Weight (kg) | 68.7 ± 9.7 | 71.7 ± 6.6 |
| BMI (kg/m$^2$)[c] | 26.0 ± 3.9 | 25.7 ± 1.4 |

[a] Intensive care unit

[b] Standard error of mean

[c] Body mass index

Table 2 Marker of nutritional status of intensive care unit patients of Ghaem Hospital in Mashad

| ICU patients | Admission | Discharge | *p* value |
|---|---|---|---|
| Weight (kg) | 68.7 ± 9.7 | 64. 8 ± 9.7 | 0.00 |
| TSF[a] (mm) | 20.5 ± 8.3 | 18.1 ± 7.6 | 0.00 |
| BMI[b] (kg/m$^2$) | 26.0 ± 3.9 | 24.2 ± 3.4 | 0.00 |
| Fat percent (%) | 31.4 ± 16.9 | 29.9 ± 15.9 | 0.78 |
| Fat mass (kg) | 22.5 ± 12.7 | 19.9 ± 11.0 | 0.49 |
| Lean body mass (kg) | 47.7 ± 11.4 | 46.2 ± 11.1 | 0.67 |
| Total body water (kg) | 52.9 ± 16. 6 | 53.9 ± 15.9 | 0.83 |
| Pre albumin (g/dl) | 22.2 ± 13.9 | 43.9 ± 39.9 | 0.06 |
| Albumin (g/dl) | 3.7 ± 0.7 | 3.9 ± 0.8 | 0.42 |
| Total protein (g/dl) | 6.6 ± 1.1 | 7.5 ± 1.5 | 0.02 |
| hs-CRP (mg/l) | 19.4 ± 16.3 | 13.8 ± 14.5 | 0.11 |
| Food intake (kcal/day) | 1732.3 ± 662 | 1767.1 ± 537.1 | 0.68 |
| NRS 2002 (*N* with score ≥3)[c] | 47.6% | 38.1% | 0.50[d] |
| NRS 2002 score | 2.71 ± 0.90 | 2.67 ± 1.06 | 0.66 |

[a] Triceps skinfold

[b] Body mass index

[c] The patient with score ≥3 is nutritionally at risk

[d] McNemar test

## Discussion

### NRS 2002 method

In this study, we found that malnutrition was common in the ICU of Ghaem hospital in Mashhad, as prevalence of malnutrition was 47.6% on admission and 38.1% at the time of discharge using NRS 2002 method. Nutritional status was slightly improved on discharge using this method due to decrease in severity of disease at the end of ICU stay (not significant). Data are consistent with the finding of Delgado and colleagues, who evaluated the incidence of hospital malnutrition at a pediatric tertiary intensive care unit [22]. It is also consistent with the finding of McCain study that was estimated that the incidence of malnutrition in ICU patients could be as high as 50% [8].

### hs-CRP

In this study, hs-CRP in the ICU patients on admission was over the cutoff point for this inflammatory cytokine in healthy persons, which is consistent with other studies that measured this negative acute phase responder in patients with stroke and cardiovascular accidents [23–25]. Indeed in this study, there was no significant difference between the hs-CRP of patients on admission and discharge; it was still over the upper limit. In Luxembourg study [26], it was concluded that patients with hs-CRP values higher than 3.3 mg/l had an increased risk for idiopathic venous thromboembolism.

### Anthropometric indices

Anthropometric indices including body weight, TSF and also BMI of patients pointed to deterioration during their stay in the ICU. This is consistent with previous study ICU patients at Hammersmith and Charing Cross Hospitals in London [16]. Results from this study are also consistent with the finding of Giner and colleagues [5], who studied 129 patients admitted to the ICU, followed them up until discharge and found that 43% were malnourished [5].

### Bio impedance analysis

Patients had lost equal percentages of fat and lean body mass during their ICU stay. To the best of our knowledge, this is one of the few studies used BIA in ICU to assess the body composition. Robert et al. [19] previously showed that body-composition changes determined by BIA represent a feasible adjunctive method for evaluating and monitoring nutritional status in ICU patients. In a study, the variations in the body composition of the critical ill patients during the first 7 days after ICU admission were assessed [27]. The observational study included 50 critically ill patients and the body composition calculations were performed using the Faulkner, Rocha, Wurch and Matiegka formulae. Results showed that patients lost muscle mass and had an increase in fat mass [27]. Another study by Reid and colleagues in critical care patients showed weight loss during the stay in ICU. Serial measurements of both mid-upper arm circumference and muscle thickness, using ultrasound, were performed by Reid and colleagues [28] in 50 critically ill patients. Muscle wasting was identified in 96% of the patients.

### Limitations

This study had methodological limitations. The study group represented a typical heterogeneous neurological ICU population with the associated problems. Nature of the patients in ICU limited the number of sample size as it was difficult to find the relatives to assent on admission for those were not alert enough to consent. Sample size was also reduced because eight patients had exclusion criteria which excluded them from the study. The use of only two times 1-day record to calculate energy intake was another limitation of the study. Nevertheless, the main aim was to investigate the malnutrition on admission and discharge of ICU patients in hospital and statistically significant results have been established in this report. In spite of these limitations, observations from this study suggested deterioration in anthropometrics during ICU stay. Although we used BIA in the critical care patients, it was affected by the amount of body water, as ICU patients may be both dehydrated and/or over-hydrated.

## Conclusion

This study showed that prevalence of malnutrition was as high as 47.6% on admission. The nutritional status of patients was slightly improved over the period of their stay in hospital (not significant) using NRS 2002 method, although patients lost weight during their stay in the ICU due to the critical care situation.

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**Conflict of interest** None.

## Appendix

See Table 3

**Table 3** Age, sex, methods of feeding after admission, energy intakes after admission, length of stay and diagnosis of intensive care patients

| No | Age (years) | Sex | Feeding method[a] | EI[b] | LOS[c] | Diagnosis |
|---|---|---|---|---|---|---|
| 1 | 40 | Female | Oral | 2,218 | 16 | Sinusoidal thrombosis |
| 2 | 80 | Male | Enteral | 2,238 | 28 | CVA |
| 3 | 36 | Female | Enteral | 2,238 | 35 | Mielitis transversa |
| 4 | 37 | Female | Oral | – | 10 | Thrombosis |
| 5 | 34 | Female | Enteral | 2,238 | 21 | Myasthenia |
| 6 | 26 | Male | Oral | 1,535 | 15 | Convulsion |
| 7 | 36 | Female | Enteral | 2,238 | 45 | Myasthenia |
| 8 | 33 | Male | Oral | 1,706 | 45 | Convulsion |
| 9 | 54 | Male | Enteral | 2,238 | 10 | Intracranial hemorrhage |
| 10 | 74 | Male | Enteral | 2,238 | 27 | G.B |
| 11 | 46 | Female | Enteral | 2,238 | 36 | Myasthenia |
| 12 | 60 | Female | Oral | 1,499 | 14 | Thrombosis |
| 13 | 27 | Male | Enteral | 2,238 | 8 | Encephalopathy |
| 14 | 53 | Male | Enteral | 2,238 | 13 | CVA |
| 15 | 26 | Female | Oral | 1,822 | 14 | Myasthenia |
| 16 | 42 | Male | Enteral | 2,238 | 15 | SAH |
| 17 | 65 | Male | Enteral | 2,238 | 15 | CVA |
| 18 | 71 | Female | Oral | – | 14 | GBS |
| 19 | 29 | Female | Oral | – | 14 | Thrombosis |
| 20 | 39 | Female | Oral | 1,815 | 16 | SAH |
| 21 | 60 | Male | Enteral | 1,815 | 13 | CVA |
| 22 | 64 | Male | Enteral | 1,815 | 15 | GBS |
| 23 | 87 | Female | Enteral | 1,815 | 11 | SAH |
| 24 | 33 | Female | Enteral | 1,815 | 10 | Sinusoidal thrombosis |
| 25 | 44 | Male | Oral | 1,815 | 14 | Convulsion |
| 26 | 20 | Female | Oral | 2,167 | 7 | Thrombosis |
| 27 | 27 | Female | Enteral | 1,815 | 8 | Decreased level of consciousness |
| 28 | 54 | Male | Enteral | – | 12 | Myasthenia |
| 29 | 50 | Female | Enteral | 1,815 | 20 | Myasthenia |

[a] After admission

[b] Energy intakes after admission (kcal/day)

[c] Length of stay in ICU (day)

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