# Evaluation of the Effect of Enteral Versus Combined Entero-Parenteral Nutrition on Critically Ill Geriatric Patients

Ahmed SI[1], El-Sayed NA[2], El-Reweny EM[3], Doha MM[1]

[1]Department of Internal Medicine, Faculty of Medicine, Alexandria University, Egypt
[2]Department of Nutrition, High Institute of Public Health, Alexandria University, Egypt
[3]Department of Critical Care Medicine, Faculty of Medicine, Alexandria University, Egypt
dr_ehab_elreweny@yahoo.com

**Abstract**. **Introduction:** Malnutrition is a wide term that embraces nutrient and energy imbalance including both over-nutrition and under-nutrition. In elderly malnutrition is prevalent, even in the developed countries. The nutritional status of elderly individuals is difficult to estimate. Several studies have shown that mortality and morbidity rates decreased with improvement of the nutritional status. Thus nutritional therapy is an integral part of critically ill patients' therapy, aiming at restoring and/or preserving body protein mass and providing adequate amount of energy. **Methods:** This study was conducted on 50 geriatric critically ill patients of both sexes admitted to Critical Care Medicine department in Alexandria Main hospital and they were classified randomly into two groups: Group I: including 25 patients will receive enteral feeding. Group II: including 25 patients will receive combined enteral and parenteral nutrition.The patients were followed up till their discharge from the ICU. All patients included in the study was subjected to the following, complete history taking, complete physical examination, routine laboratory investigations and pre-albumin were taken on admission and on discharge. NRS score and acute physiology and chronic health evaluation (APACHE II) were done on admission, geriatric nutritional risk index (GNRI) was also done on admission and on discharge, The caloric intake will be calculated according to the ideal body weight, age and gender. The kilocalories will be supplied as 25k.cal/kg/day. In both groups EN will be initiated on the day of admission provided that there are no contraindications and it will be supplied as lactose free diet and contain 1Kcal/ml, this is the standard formula which will be modified according to the medical condition of the patients. In group II PN was started on the next day and was calculated as the difference between the calculated calories and the delivered calories of the previous day. It was in the form of 50% carbohydrates, 30% fat and 20% proteins. When the EN covered 80% of the caloric need, PN was stopped and whenever the caloric intake falls below 50% PN was restarted. **Results:** This study showed that there was no statistically significant difference between the both groups regarding NRS score. There was statistically significant difference between the both groups regarding the GNRI and the risk of malnutrition on discharge as in group II patients the GNRI value increased with significant decrease in the risk of malnutrition on discharge, while in group I patients the GNRI value was not significantly increased with no significant decrease in the risk of malnutrition (<0.001).There was statistically significant difference between the both groups as regard the incidence of complications occurring during feeding as they were higher among group I than group II ($p$ = 0.008) particularly aspiration ($p$ <0.001), while there was no statistically significant difference between the two groups as regard other complication. There was no statistically significant difference between the both groups as regard the per-albumin on admission. As regard the mean Pre-albumin level on discharge there was statistically significant difference between the both groups as regard the pre-albumin level which increased significantly on discharge in group II patients while no significant increase in group I patients ($p$ <0.001). There was statistical difference between the two studied groups as regard the plasma protein levels as group II shows significant increase in the plasma protein levels on discharge when compared with group II also there was statistically significant difference between the two groups as regard the total caloric intake. **Conclusions:** Anthropometric measurements are good indicators for elderly nutritional status. Pre-albumin level is well correlated with the nutritional status of elderly patient. Pre-albumin level can be used as a marker for early detection of malnutrition and acute changes in the nutritional status while albumin level, if used, should be used for chronic malnutrition. Pre-albumin and albumin levels are well correlated to GNRI. There is no correlation between APACHE II score and pre-albumin level. Nutrition supplied through the combined entero-parenteral route improved the nutritional status of critically ill elderly patient more than enteral route alone.
[Ahmedsi, El-Sayedna, El-Rewenyem, Dohamm. **Evaluation of The Effect of Enteral Versus Combined Entero-Parenteral Nutrition on Critically Ill Geriatric Patients.** *J Am Sci* 2015;11(2):1-12]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 1

**Key words:** Malnutrition, nutritional therapy, enteral nutrition, parenteral nutrition.

## 1. Introduction

Malnutrition is a wide term that embraces nutrient and energy imbalance including both over-nutrition and under-nutrition. In elderly malnutrition is prevalent, even in the developed countries.[1]

Poor nutritional status in the elderly is associated with numerous factors, including decline in cognitive and functional status, chronic diseases, medications, poor dentition, isolation, and poverty. The nutritional status of elderly individuals is difficult to estimate. Despite the high prevalence of malnutrition in the elderly and the known association between malnutrition and poor outcome, malnutrition often goes unrecognized and untreated during hospitalization. This is partly because the routine nutritional tests in current use are often not done because of time limits and, in part, because of the frailty of geriatric patients.[2]

Protein-energy malnutrition has been reported in up to 62% of hospitalized elderly patients, and up to 85% of residents of nursing homes.[3] Among hospitalized elderly, critically ill elderly patients have poorer nutritional status which has been associated with more prolonged hospital stay and worse outcome and increased mortality.[4] As critically ill patients have increased metabolic requirements due to increased protein breakdown and synthesis and changed substrate turnover and vary depending on the clinical situation. Also there is wide patient variation between and within patients on different days. The catabolic depletion of protein reserves is one of the most striking features of the critically ill.[5] Several studies have shown that mortality and morbidity rates decreased with improvement of the nutritional status.[6] Thus nutritional therapy is an integral part of critically ill patients' therapy, aiming at restoring and/or preserving body protein mass and providing adequate amount of energy.[7]

Factors influencing the nutritional status in elderly persons may be divided into three categories: psychological, social, and medical. Psychological disorders such as depression and dementia are highly correlated with loss of body weight in nursing homes and are the major causes of weight loss in free-living elderly individuals.

In addition, social isolation, low socioeconomic status, and poverty are also associated with reduced dietary intake and weight loss.[8] Medical factors such as, heart disease, cancer, arthritis, osteoporosis, diabetes, senile dementia, the use prescription medicines, poor dentition, decrease in taste and smell sensations and an inability to regulate food intake have all been suggested to decrease appetite and adversely affect nutritional status in older adults.[9]

There are two currently available guidelines for nutritional support for the critically ill patients; American/Canadian and European clinical practice guidelines which differ in their timing of initiating the completing parenteral nutrition.[10] The American/Canadian guidelines recommend starting the PN on day 5,[11] while the European guidelines for PN in intensive care recommend the administration of supplemental PN within 2 days of ICU admission to patients who cannot be fed sufficiently via the enteral route.[12] In spite of such association between malnutrition and adverse outcomes, it has not been investigated in adequately whether combined enteral and parenteral feeding would provide favorable outcome in the course of critically ill patients.[10]

**Aim of the work**

The aim of the work was to compare between the effect of enteral and combined entero-parenteral nutrition on the outcome of critically ill elderly patients.

## 2. Patients and Methods

This study was conducted on 50 geriatric critically ill patients of both sexes admitted to Critical Care Medicine department in Alexandria Main hospital and they were classified randomly into two groups: Group I: including 25 patients will receive enteral feeding. Group II: including 25 patients will receive combined enteral and parenteral nutrition. The patients were followed up till their discharge from the ICU. Inclusion criteria were; Age: 65 years and above. Nutritional Risk Screening score (NRS) score equal or higher than three upon ICU admission. Exclusion criteria were; Malignancy, End stage renal or liver disease, Moribund on ICU admission, Patients transferred from other ICU with established nutritional therapy, Patients with diabetic ketoacidotic coma or hyperosmolar hyperglycemic non ketotic coma, Nutritional Risk Screening score less than three, Severe short bowel syndrome.

All patients included in the study was subjected to the following, complete history taking, complete physical examination, routine laboratory investigations and pre-albumin were taken on admission and on discharge. NRS score and acute physiology and chronic health evaluation (APACHE II) were done on admission, geriatric nutritional risk index (GNRI) was also done on admission and on discharge, The caloric intake will be calculated according to the ideal body weight, age and gender. The kilocalories will be supplied as 25k.cal/kg/day. In both groups EN will be initiated on the day of admission provided that there are no contraindications and it will be supplied as lactose free diet and contain 1Kcal/ml, this is the standard formula which will be modified according to the medical condition of the patients. In group II PN was started on the next day and was calculated as the difference between the

calculated calories and the delivered calories of the previous day. It was in the form of 50% carbohydrates, 30% fat and 20% proteins. When the EN covered 80% of the caloric need, PN was stopped and whenever the caloric intake falls below 50% PN was restarted.

**Statistical analysis[13]:**

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0.[14] Qualitative data (age, gender, and preexisting conditions) were described using number and percent. Quantitative data (Presepsin, Albumin, and Pre-albumin) were described using median, minimum and maximum as well as mean and standard deviation. For qualitative variables (Age, gender, and preexisting conditions), Chi-square test was used. When more than 20% of the cells had expected count less than 5, correction for Chi-square was conducted using Fisher's Exact test or Monte Carlo correction. The distribution of quantitative variables was tested for normality using Kolmogrov-Smirnov test and Shapiro-Wilk test. D'Agstino test was used if there was a conflict between the two previous tests.

## 3. Results

Group I and Group II were homogeneous in terms of size, demographic characteristics, and preexisting medical history with no statistically significant difference between them (Tables 1 and 2).

**Table (1): Comparison between Group I and Group II according to demographic characteristics**

| | Group I (n=25) | | Group II (n=25) | | *p* |
|---|---|---|---|---|---|
| **Gender** | **No.** | **%** | **No.** | **%** | |
| Male | 16 | 64.0 | 10 | 40.0 | tp =0.105 |
| Female | 9 | 36.0 | 15 | 60.0 | |
| **Age** | | | | | |
| Min. – Max. | 66.0 – 80.0 | | 65.0 – 80.0 | | |
| Mean ± SD. | 72.16 ± 4.19 | | 70.28 ± 3.85 | | p = 0.089 |
| Median | 71.0 | | 70.0 | | |

*P*, p value for comparing between the two studied groups; t, Student t-test; $X^2$, Chi square test; *: Statistically significant at $p \leq 0.05$.

**Table (2): Comparison between Group I and Group II according to preexisting medical history**

| Preexisting Conditions | Group I No.** | %* | Group II No.** | %* | *p* |
|---|---|---|---|---|---|
| No | 2 | 8.0 | 1 | 4.0 | FEp = 1.000 |
| Diabetes mellitus | 7 | 28.0 | 6 | 24.0 | x2p = 0.882 |
| Hypertension | 15 | 60.0 | 16 | 64.0 | $X^2$p = 0.771 |
| Cardiovascular disease | 8 | 33.0 | 6 | 24.0 | x2p = 0.529 |
| Respiratory disease | 5 | 20.0 | 3 | 12.0 | FEp = 0.702 |
| Gastro intestinal disorder | 0 | 0.0 | 3 | 12.0 | FEp = 0.235 |
| Others | 1 | 4.0 | 4 | 16.0 | FEp = 0.349 |

*P, p* value for comparing between the two studied groups; $X^2$, Chi square test; FE, Fisher Exact test;*, Statistically significant at $p \leq 0.05$; **, multiple.

**Table (3): Comparison between the two studied groups according to the BMI**

| BMI (Kg/m$^2$) | Group I (n=25) | | | Group II (n=25) | | | Test of sig. |
|---|---|---|---|---|---|---|---|
| | Mean ± SD | No. | % | Mean ± SD | No. | % | |
| **On admission** | | | | | | | |
| Normal | 19.41±0.65 | 3 | 12.0 | 19.52±0.50 | 3 | 12.0 | |
| Mild | 17.90±0.35 | 11 | 44.0 | 17.95±0.35 | 13 | 52.0 | $^{MW}$p = 0.735 |
| Moderate | 16.46±0.48 | 11 | 44.0 | 16.46±0.48 | 9 | 36.0 | |
| Severe | - | 0 | 0.0 | - | 0 | 0.0 | |
| Min. – Max. | 16.0 – 20.0 | | | 16.0 – 20.0 | | | $^{t}$p = 0.805 |
| Mean ± SD | 17.68 ± 1.19 | | | 17.60 ± 1.09 | | | |
| **On discharge** | | | | | | | |
| Normal | 19.26±0.69 | 4 | 16.0 | 19.39±0.63 | 22 | 88.0 | |
| Mild | 17.89±0.37 | 12 | 48.0 | 18.0±- | 3 | 12.0 | $^{MW}$p<0.001* |
| Moderate | 16.46±0.48 | 9 | 36.0 | - | - | - | |
| Severe | - | 0 | 0.0 | - | 0 | 0.0 | |
| Min. – Max. | 16.0 – 20.0 | | | 17.0 – 20.0 | | | $^{t}$p = <0.001* |
| Mean ± SD | 17.70 ± 1.20 | | | 19.13 ± 0.86 | | | |

*P, p* value for comparing between the two studied groups; t, Student t-test; MC, Monte Carlo test; *, Statistically significant at $p \leq 0$.

Regarding the BMI on admission; There was no statistically significant difference between the two studied groups as regard the BMI on admission (tp=0.805). While there was statistically significant difference between the two studied groups as regard the BMI on discharge which increased in group II patients on discharge significantly with no significant increase among group I patients (tp=<0.001*) (Table 3). There was no statistically significant difference between the two studied groups as regard the APACHE II score (tp = 0.806) and the risk of death (MWp = 0.927) (table 4).

**Table (4): Comparison between the two studied groups according to APACHE II score and risk of death**

| APACHE II score and risk of death | Group I (n=25) | Group II (n=25) | Test of sig. |
|---|---|---|---|
| **APACHE II score** | | | |
| Min. – Max. | 10.0 – 31.0 | 9.0 – 31.0 | $^{t}p = 0.806$ |
| Mean ± SD. | 19.56 ± 5.99 | 19.12 ± 6.60 | |
| **Risk of death** | | | |
| Min. – Max. | 15.0 – 75.0 | 8.0 – 75.0 | $^{MW}p = 0.927$ |
| Mean ± SD. | 34.20 ± 18.12 | 33.44 ± 18.57 | |

P, p value for comparing between the two studied group, t; Student t-test, MW, Mann Whitney test.

There was no statistically significant difference between the two groups regarding NRS score (p=0.338) (Table 5).

**Table (5): Comparison between the two studied groups according to the risk of malnutrition**

| NRS | Group I (n=25) | Group II (n=25) | *p* |
|---|---|---|---|
| Min. – Max. | 3.0 – 5.0 | 3.0 – 5.0 | 0.338 |
| Mean ± SD | 4.08 ± 0.49 | 4.24 ± 0.66 | |

P, p value for comparing between the two studied group; t, Student t-test.

There was no statistically significant difference between the two groups regarding the GNRI and the risk of malnutrition on admission (tp =0.055).

There was statistically significant difference between the two groups regarding the GNRI and the risk of malnutrition on discharge as in group II patients the GNRI value increased with significant decrease in the risk of malnutrition on discharge, while in group I patients the GNRI value was not significantly increased with no significant decrease in the risk of malnutrition (*p* <0.001*) (Table 6).

**Table (6): Comparison between the two studied groups according to the risk of malnutrition**

| GNRI | Group I (n=25) | | | Group II (n=25) | | | Test of sig. |
|---|---|---|---|---|---|---|---|
| | Mean ± SD | No. | % | Mean ± SD | No. | % | |
| **On admission** | | | | | | | |
| Low | - | 0 | 0.0 | - | 0 | 0.0 | |
| Moderate | 72.0±1.41 | 2 | 8.0 | - | 0 | 0.0 | $^{MW}p = 0.153$ |
| High | 68.93±8.61 | 23 | 92.0 | 63.0 ± 13.36 | 25 | 100.0 | |
| Min. – Max. | 45.95 – 79.14 | | | 6.80 – 79.80 | | | $^{t}p =0.055$ |
| Mean ± SD | 69.17±8.29 | | | 63.0 ± 13.36 | | | |
| **On discharge** | | | | | | | |
| Low | - | 0 | 0.0 | 96.11±4.19 | 21 | 84.0 | |
| Moderate | 83.75±2.89 | 10 | 40.0 | 87.72±5.71 | 4 | 16.0 | $^{MW}p<0.001^{*}$ |
| High | 77.63±2.67 | 15 | 60.0 | - | 0 | 0.0 | |
| Min. – Max. | 72.50 – 89.90 | | | 78.22 – 104.0 | | | $^{MW}p<0.001^{*}$ |
| Mean ± SD | 80.08 ± 4.08 | | | 94.29 ± 6.07 | | | |

P, p value for comparing between the two studied group; t, Student t-test, MW, Mann Whitney test.

There was no statistically significant difference between the two studied groups as regard the pre-albumin level on admission (*p* =0.492). While There was statistically significant difference between the two studied groups as regard the pre-albumin level on discharge which increased significantly in group II

patients while no significant increase in group I patients ($p$ <0.001*) (Tables 7, 8).

**Table (7): Comparison according to the Pre-albumin level on admission in the two studied groups**

| Pre –albumin (mg/dl) on admission | Group I (n=25) | | | Group II (n=25) | | | $p$ |
|---|---|---|---|---|---|---|---|
| | Mean ± SD | No. | % | Mean ± SD | No. | % | |
| Normal | 19.58±3.53 | 4 | 16.0 | 23.37±9.03 | 3 | 12.0 | 0.492 |
| Mild deficiency | 11.95±1.20 | 2 | 8.0 | 12.08±1.49 | 5 | 20.0 | |
| Moderate deficiency | 7.07±1.67 | 7 | 28.0 | 8.10 ± 0.0 | 1 | 4.0 | |
| Severe deficiency | 2.43±1.44 | 12 | 48.0 | 2.23 ± 0.94 | 16 | 64.0 | |

P, Mann Whitney test.

**Table (8): Comparison according to the Pre-albumin level on discharge in the two studied groups**

| Pre- albumin (mg/dl) on discharge | Group I (n=25) | | | Group II (n=25) | | | $p$ |
|---|---|---|---|---|---|---|---|
| | Mean ± SD | No. | % | Mean ± SD | No. | % | |
| Normal | 25.38±9.89 | 5 | 20.0 | 46.24±15.99 | 17 | 68.0 | 0.001* |
| Mild deficiency | 12.49±1.60 | 3 | 12.0 | 13.83±1.14 | 6 | 24.0 | |
| Moderate deficiency | 7.93±1.38 | 10 | 40.0 | 8.50±0.71 | 2 | 8.0 | |
| Severe deficiency | 4.40±0.75 | 7 | 28.0 | - | 0 | 0.0 | |

P, Mann Whitney test.

**Table (9): Comparison between the two studied groups according to the complications of feeding**

| Complications | Group I (n=25) | | Group II (n=25) | | Test of sig. |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| No | 2 | 8.0 | 10 | 40.0 | p = 0.008* |
| Refeeding syndrome | 4 | 16.0 | 0 | 0.0 | FEp = 0.110 |
| Aspiration | 15 | 60.0 | 3 | 12.0 | p <0.001* |
| Infection | 1 | 4.0 | 0 | 0.0 | FEp = 1.000 |
| Metabolic | 0 | 0.0 | 0 | 0.0 | - |
| Gastro intestinal | 5 | 20.0 | 8 | 32.0 | p = 0.333 |
| Dumping syndrome | 0 | 0.0 | 4 | 16.0 | FEp = 0.110 |

P, p value for comparing between the two studied groups; $X^2$: Chi square test; FE, Fisher Exact test;* Statistically significant at p ≤ 0.05.

There was statistically significant difference between the two studied groups as regard the incidence of complications occurring during feeding as the complications were higher among group I than group II (p=0.008*) particularly aspiration ($p$ <0.001*), while there was no statistically significant difference between the two groups as regard other complication (Table 9).

There was no statistical significant difference between the two studied groups as regard serum albumin level neither on admission (p=0.529) nor on discharge (p=0.212) (Table 10).

**Table (10): Serum albumin in the two studied groups on admission and on discharge**

| Serum albumin (gm/dl) | Group I (n=25) | | | Group II (n=25) | | | MWp1 |
|---|---|---|---|---|---|---|---|
| **On admission** Mean ± SD. | 2.48±0.43 | | | 2.29 ± 0.45 | | | 0.529 |
| | Mean ± SD. | No. | % | Mean ± SD. | No. | % | |
| Normal | - | 0 | 0.0 | - | 0 | 0.0 | |
| Mildly to moderately deficient | 2.79±0.14 | 15 | 60.0 | 2.75±0.07 | 11 | 44.0 | |
| Severely deficient | 2.0 ±0.18 | 10 | 40.0 | 1.92±0.21 | 14 | 56.0 | |
| **On discharge** Mean ± SD. | 2.69 ± 0.39 | | | 2.84 ± 0.34 | | | 0.212 |
| Normal | - | 0 | 0.0 | - | 0 | 0.0 | |
| Mildly to moderately deficient | 2.91±0.27 | 17 | 68.0 | 2.96±0.21 | 21 | 84.0 | |
| Severely deficient | 2.23±0.07 | 8 | 32.0 | 2.20±0.08 | 4 | 16.0 | |
| WRSTp2 | 0.017* | | | <0.001* | | | |

p1, p value for comparing between the two studied group; p2, p value for comparing between on admission and discharge in each group; MW, Mann Whitney test; WRST, Wilcoxon signed ranks test.

There was statistically significant difference between the two groups as regard the level of plasma proteins on discharge (p<0.001*), as group II showed significant increase in the level of plasma proteins while group I showed very mild increase in the plasma proteins level (Table 11).

**Table (11): Total plasma proteins level in the two studied groups on admission and on discharge**

| Total plasma proteins (gm/dl) | Group I (n=25) | Group II (n=25) | $p_2$ |
|---|---|---|---|
| **On admission** Min – Max Mean ± SD. | 2.80 - 6.00 5.35 ± 0.68 | 4.70 - 5.70 5.37 ± 0.39 | 0.528 |
| **On discharge** Min – Max Mean ± SD. | 3.00 - 6.20 5.81 ± 0.61 | 5.70 - 6.80 6.47 ± 0.46 | <0.001* |
| **$p_1$** | <0.001* | <0.001* | |

p1, p value for Wilcoxon signed ranks test for comparing between on admission and discharge; p2, p value for Mann Whitney test for comparing between the two groups; *, Statistically significant at p ≤ 0.05.

A correlation between APACHE II score was studied with GNRI, pre-albumin, albumin and BMI in the two groups. There was no statistical significance of this correlation (r=0.219, p=0.127) (r=0.152, p=0.294), (r=0.141, p=0.328) and (r= 0.169, p=0.240) respectively (Table 12).

**Table (12): Correlation between APACHE with GNRI, pre albumin, serum albumin and BMI on admission**

| Admission | | APACHE Group I | Group II | Total sample |
|---|---|---|---|---|
| **GNRI** | **r** | 0.257 | 0.201 | 0.219 |
| | **p** | 0.215 | 0.335 | 0.127 |
| **Pre-albumin** | **r** | 0.150 | 0.152 | 0.152 |
| | **p** | 0.473 | 0.469 | 0.294 |
| **Albumin** | **r** | 0.386 | -0.076 | 0.141 |
| | **p** | 0.057 | 0.717 | 0.328 |
| **BMI** | **r** | 0.234 | 0.105 | 0.169 |
| | **p** | 0.260 | 0.618 | 0.240 |

r: Pearson coefficient.

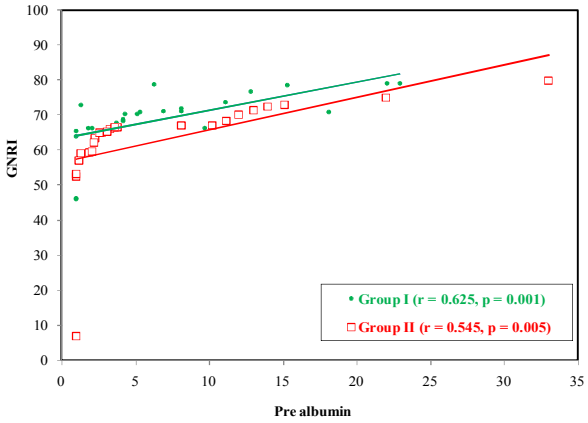


**Figure (1): Correlation between pre-albumin with GNRI on admission**

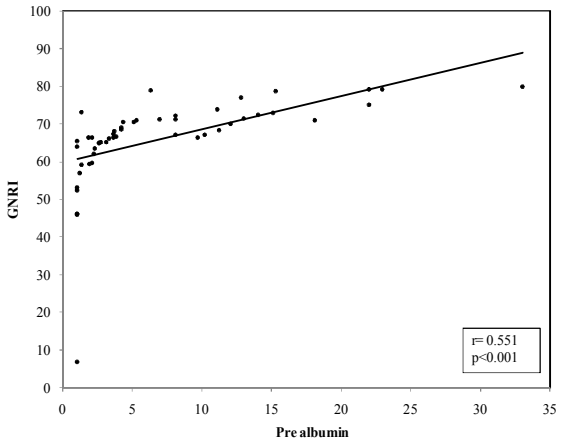


**Figure (2): Correlation between pre-albumin with GNRI on admission in total sample**

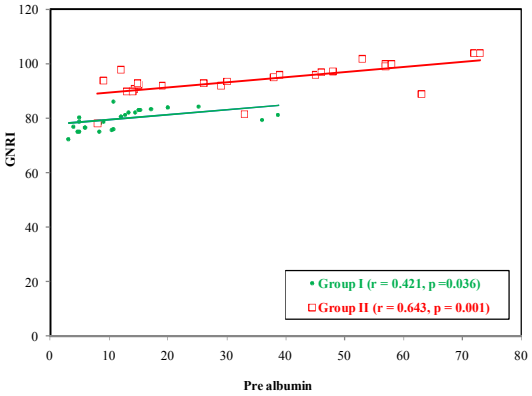


**Figure (3): Correlation between pre-albumin with GNRI on discharge**

There was no statistically significant difference between in both groups as regard the correlation between serum pre-albumin and BMI neither on admission (r=0.164, p=0.254) nor on discharge (r=0.271, p=0.057). But there was statistically significant difference between in both group as regard

the correlation between pre-albumin level and GNRI on admission (r=0.551*, p<0.001*) and on discharge (r=0.750*, p=0.001*) (Figures 1 -4).

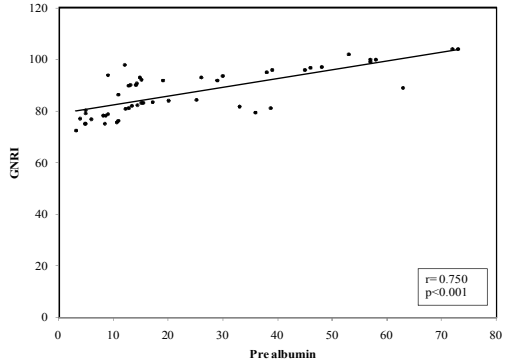


**Figure (4): Correlation between pre-albumin withGNRI on discharge in total sample**

A correlation was done between albumin with BMI and GNRI on both admission and discharge in the two studied groups.

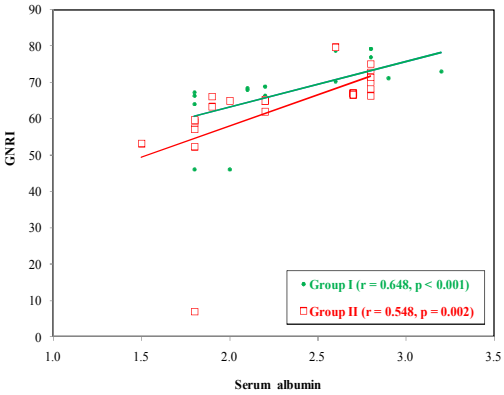


**Figure (5): Correlation between serum albumin with GNRI on admission**

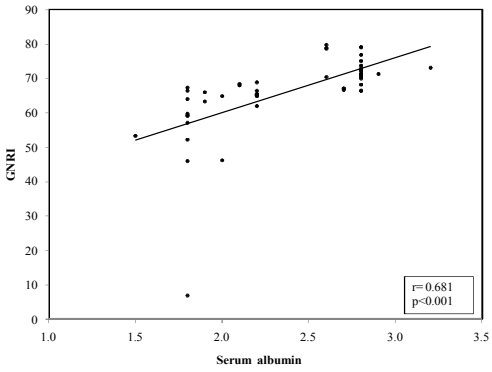


**Figure (6): Correlation between serum albumin with GNRI on admission total sample**

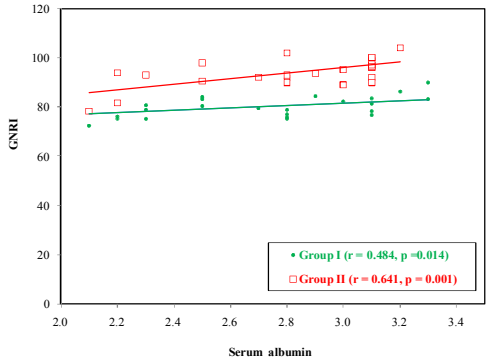


**Figure (7): Correlation between serum albumin and GNRI on discharge**

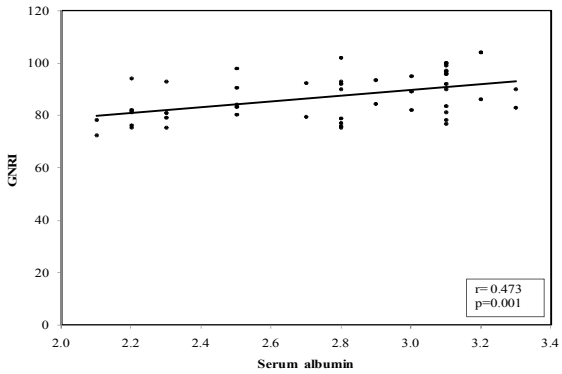


**Figure (8): Correlation between serum albumin and GNRI on discharge in total sample**

There was no statistically significant difference between both groups as regard the correlation between serum albumin and BMI neither on admission (r=0.217, p=0.130) nor on discharge (r=0.098, p 0.498). But there was statistically significant difference between in both group as regard the correlation between albumin level and GNRI on admission (r=0.618*, p<0.001*) and on discharge (r=0.473*, p=0.001*) (Figures 5- 8).

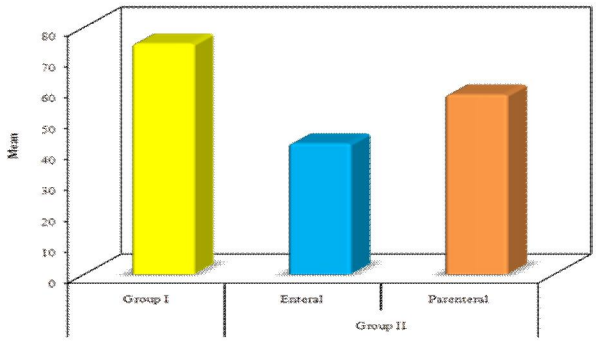


**Figure (9): Comparison between the two studied groups according to percent of energy intake (kcal)**

In group I; the mean of the total caloric need was 2057.21±304.13 Kcal/day. While In group II; the mean of the total caloric need 2168.11±367.76 Kcal/day, There was statistically significant difference between the two groups as regard the total caloric intake as patients of group I couldn't receive their full nutritional requirements though enteral route alone while patients in group II received their full caloric and nutritional requirement through the enteral route complemented by the parenteral route (Figure 9).

**4. Discussion**

Malnutrition is a wide term that embraces nutrient and energy imbalance including both over-nutrition and under-nutrition. In elderly malnutrition is prevalent, even in the developed countries.[1]

This study showed that,as regard the mean age; in group I the mean age was 72.16 ± 4.19 years, while in group II the mean age was 70.28± 3.85 years. This coincides with Olsen *et al.,*[15] who found in his study "Risk of malnutrition and health-related quality of life in community-living elderly men and women" that malnutrition and being underweight are more common in the elderly than in adults of other ages.

Regarding the gender; among group I patients 64% were males and 36% were females, while among group II patients 40% were males and 60% patients were females. This coincides with Gracia *et al.,* [16] who found that gender is not an issue considering the trend of malnutrition by anthropometric indices and hand in hand, both sexes of the various age groups experience similar nutritional deterioration.

According to the medical history, in group I patients; 8.3% had no medical history, 29.9% had diabetes 62% had hypertension, 33% had cardiovascular disease, 20.8% had respiratory problem, 4.2% had other medical history, while In group II patients; 4% had no medical history, 24% had diabetes, 64% had hypertension, 24% had cardiovascular disease, 12% had respiratory problem, 12% had gastro-intestinal disease, 16% had other medical history. This coincides with Nihtila *et al.,* [17] whose study showed that dementia, Parkinson's disease, stroke, depressive symptoms, other mental health problems, hip fracture and diabetes were strongly associated with increased risk of long-term institutionalization and malnutrition.

Regarding the factors related to weight loss; in group I patients; 68% had poor appetite, 32% had fair appetite, 16% had vomiting, 24% had dysphagia and 24% had nausea. While in group II patients; 72% had poor appetite, 28% had fair appetite, while 48% had vomiting, 28% had dysphagia, 60% had nausea, 16% had diarrhea and 4% had constipation. Regarding nausea and vomiting as they were higher in group II than group I ($p$ = 0.015*). This is in agreement with Hickson *et al.,* [18] who found that anorexia, nausea and vomiting are of the major causes of malnutrition in elderly.

Regarding the BMI on admission; among group I patients; 3 had BMI ranged from 18.5-20 kg/m2 (12%) with a mean value equal to 19.41±0.65 kg/m2, 11 patients had BMI >17-<18.5kg/$m^2$ (44%) with a mean value equal to 17.90±0.35 kg/$m^2$ and 11 patients had BMI 16-17kg/$m^2$ (44%) with a mean value equal to 16.46±0.48 kg/$m^2$.

While in group II; three patients had BMI ranged from 18.5-20 kg/$m^2$ (12%) with a mean value equal to 19.52±0.50 kg/$m^2$, 13 patients had BMI >17-<18.5kg/$m^2$ (52%) with a mean value equal to 17.95±0.35 kg/m2 and 9 patients had BMI 16-17kg/$m^2$ (36%) with a mean value equal to 16.46±0.48 kg/$m^2$.

There was no statistically significant difference between the two studied groups as regard the BMI on admission (tp = 0.805).

Regarding the BMI on discharge; among group I patients 4 had BMI from 18.5-20 kg/$m^2$ (16%) with a mean value equal to 19.26±0.69 kg/$m^2$, 12 patients had BMI >17-<18.5 kg/$m^2$ (48%) with a mean value equal to 17.89±0.37 kg/$m^2$ and 9 patients had BMI16-17kg/$m^2$ (36%) with a mean value equal to 16.46±0.48 kg/$m^2$.

While among group II patients; 22 had BMI ranged from 18.5-20 kg/$m^2$ (88%) with a mean value equal to 19.39±0.63 kg/$m^2$ and 3 patients had BMI >17-<18.5kg/$m^2$ (12%) with a mean value equal to 18.0±- kg/m2

The BMI on discharge increased in group II patients significantly with no significant increase among group I patients. This coincides with Shetty *et al.,* [19] who found in his paper that nutritional anthropometric indicators provide a reflection of the nutritional status, and BMI as an alternative and complimentary indicator of nutritional status alongside the standard methodology. But mismatches with Hickson *et al.,* [20] who found in his study that in elders, use of BMI as a nutritional assessment tool may be problematic, as an inaccurate height may be obtained and BMI does not accurately predict body composition.

Concerning the mean value of APACHE II score; in group I the mean value was 19.56 ± 5.99 with a mean risk of death equal to 34.20 ± 18.12 and in group II the mean value of APACHE II score was 19.12 ± 6.60 with a mean risk of death equal to 33.44 ± 18.57. There was no statistically significant difference between the two groups regarding the APACHE II score and risk of death.

As regard the mean value of NRS score; in group I the mean value was 4.08 ± 0.49 and in group II the mean value was 4.24 ± 0.66. There was no

statistically significant difference between the two groups regarding NRS score. This coincides with Kondrup *et al.,* [21] who found that NRS score can identify patients who are likely to benefit from nutritional support. And coincides with Drescher *et al.,* [22] who found that NRS seems to be superior compared with the MNA and serum proteins in identifying elderly patients at risk of malnutrition during acute inter-current illness. Also Kaiser *et al.,* [23] found that the Nutritional Risk Screening score should be integrated into the comprehensive geriatric assessment.

As regard the GNRI on admission; the mean value was 69.17±8.29, 25 patients in this group had high risk index of malnutrition (100%), while in group II the mean value was 63.0 ±13.36. 23 patients in this group had high risk index of malnutrition (92%) and 8 patients had moderate risk index of malnutrition (8%). This conflicts with Bouillanne *et al.,* [24] who found in his study that of 2474 elderly hospitalize patients that 12.2%, 31.4%, 29.4%, and 27.0% had major, moderate, low, and no nutrition-related risk, respectively.

Regarding the GNRI on discharge; in group I the mean value was 80.08 ± 4.08, 10 patients had low risk of malnutrition (40%) and 15 patients had moderate risk of malnutrition (60%). While in group II the GNRI mean value was 94.29 ± 6.07, 4 patients had moderate risk of malnutrition (16%) and 21 patients had low risk of malnutrition on discharge (84%). The GNRI value increased with significant decrease in the risk of malnutrition in group II on discharge, while in group I patients the GNRI value was not significantly increased with no significant decrease in the risk of malnutrition ($p$<0.001*). This coincides with Buzby *et al.,* [25] who found a correlation between severity of GNRI score and both BMI and weight loss.

According to the route of enteral feeding; in Group I; four patients had oral feeding (16%) and 21patients had their enteral feeding through NGT (84%).While in Group II; 9 patients had oral feeding (36%) and 16patients had their enteral feeding through NGT (64%).There was no statistically significant difference between the two groups regarding the enteral route of feeding. This is in agreement with Metheny *et al.,* [26] who found that 92.3% were fed through naso/oro-gastric tube and only 7.8% were fed by gastrostomy tube.

As regard the incidence of complications; among group I patients 15 patients were aspirated (60%), 5 patients had gastro-intestinal complication (20%), 4 patients had refeeding syndrome (16%), and only 2 patients had no complications (8%), while among group II patients 10 patients had no complications during feeding (40%), 3 patients were aspirated (12%), 8 patients had gastro-intestinal complications (32%) and 4 patients had dumping syndrome (16%).

The incidence of complications occurring during feeding were higher among group I than group II particularly aspiration. This coincides with Michael *et al.,* [27] who found that the incidence of aspiration is higher through oral feeding among elderly, but mismatches with Gramlich *et al.,* [28] who found in his study that The use of EN as opposed to TPN results in an important decrease in the incidence of infectious complications in the critically ill and may be less costly and EN should be the first choice for nutritional support in the critically ill. There were no differences in number of days on the ventilator, nosocomial infections, ICU length of stay, mortality.

As regard the mean pre-albumin level on admission; 4 patients in group I had normal levels (16%) with mean value equal to 19.58±3.53, 2 patients had mild deficiency (8%) with mean value equal to 11.95±1.20, 7 patients had moderate deficiency (28%) with mean value equal to 7.07±1.67 and 12 patients had severe deficiency (48%) with mean value equal to 2.43±1.44. While among group II patients; 3 had normal levels (12%) with mean value equal to 23.37±9.03, 5 patients had mild deficiency (20%) with mean value equal to 12.08±1.49, one patient had moderate deficiency (4%) with mean value equal to 8.10 ±0.0 and 16 patients had severe deficiency (64%) with mean value equal to 2.23 ± 0.94. This coincides with Sullivan *et al.,* [29] who found in his study that pre-albumin response correlates with patient outcome and patients who had low pre-albumin levels on admission had a higher rate of mortality.

As regard the mean pre-albumin level on discharge; in group I it was 15.20 ± 9.49, while in group II the mean value was 47.89 ± 16.0. There was statistically significant difference between the two studied groups as regard the pre-albumin level which increased significantly on discharge in group II patients while no significant increase in group I patients ($p$<0.001*). This is in agreement with Lopez Hellin *et al.,* [30] who found that pre-albumin level strongly responds to nutrition.

But this finding mismatches with Bauer *et al.,* [31] who examined 120 ICU patients receiving EN and placebo versus EN and PN showing no significant changes in pre-albumin by the end of the study in response to nutrition. And also mismatches with Nagata *et al.,* [32]who found in the study that there was no significant difference between the enteral group and entero-parenteral group as regard the pre-albumin level. Akira *et al.,* study was on post-operative patients who had pancreatico-dudenctomy.

As regard albumin level on admission; among group I patients 10 were severely deficient (40%) with

mean level of serum albumin equal to 2.0 ±0.18 gm/dl and 15 patients were mildly to moderately deficient (60%) with mean level of serum albumin equal to 2.79±0.14 gm/dl. While among group II patients; 14 were severely deficient (54%) with mean level of serum albumin equal to 1.92±0.21 gm/dl and 11 patients were mildly to moderately deficient (44%) with mean level of serum albumin equal to 2.75±0.07 gm/dl.

Regarding albumin level on discharge; among group I patients 8 were severely deficient (32%) with mean level of serum albumin equal to 2.23±0.07gm/dl and 17 patients were mildly to moderately deficient (68%) with mean level of serum albumin equal to 2.91±0.27gm/dl. While among group II patients; 4 patients were severely deficient (16%) with mean level of serum albumin equal to 2.20±0.08gm/dl and 21 patients were mildly to moderately deficient (84%) with mean level of serum albumin equal to 2.96±0.21gm/dl. There was no statistically significant difference between the two groups as regard serum albumin level on discharge.

As regard the correlation between APACHE II score was studied with GNRI showing no significance. This is in agreement with Lee JS et al,[33] who found that GNRI is an independent indicator of mortality in hospitalized elderly.

As regard the correlation between APACHE II score with both pre-albumin and albumin showed no significance (r=0.152, $p$=0.294) and (r=0.141, $p$=0.328). This coincides with Yap et al,[34] whose study which combined APACHE II score with albumin level on admission and 72 hours later, showed no significance as regard the accuracy in predicting hospital mortality. And also coincides with Lee *et al.,* [35] who found that pre-albumin level showed correlation with albumin (r=0.561), however did not show correlation with APACHE II (r=-0.151), SAPS (r=-0.056), SOFA (r=-0.056) and MODS (r=-0.076). And coincides with V Cerny *et al.,* [36] who found that there was no significant correlation between blood albumin, blood cholinesterase, pre-albumin and APACHE II score ($P$>0.05).

As regard the correlation between APACHE II score and BMI showed no significance (r= 0.169, $p$=0.240). This mismatches with Sungertekin *et al.,* [37] who found a significant correlation between MAC, BMI and TSF with APACHE II scores and SAPS score.

As regard the correlation between albumin and BMI in the two studied groups showed no statistical significance neither on admission (r=0.217, p=0.130) nor on discharge (r=0.098, $p$ 0.498). While studying the correlation between albumin level and GNRI showed statistical significance on admission (r=0.618*, $p$<0.001*) and on discharge (r=0.473*, $p$=0.001*). This coincides with Bouillanne *et al.,* [38] who found that the severity score correlated with albumin and GNRI but not with BMI or weight. But mismatches with Soleymanian *et al.,* [39] who found that there was a statistically significant direct correlation between serum albumin and BMI (r= 0.415, $P$=0.004). The study was done on hemodialysis patients who were excluded in our study.

As regard the correlation between there was significant correlation between pre-albumin level and GNRI on admission (r=0.551*, $p$<0.001*) and on discharge (r=0.750*, $p$=0.001*). This is in agreement with Cereda *et al.,* [40] who found a strong significant correlation between GNRI with pre-albumin and lymphocytic count.

As regard the correlation between pre-albumin and BMI on both admission and discharge in the two studied groups showed no significance (r=0.164, $p$=0.254) and (r=0.271, $p$=0.057) respectively. This is in agreement with Yovita *et al.,* [41] who found that there was no significant relationship between albumin, pre-albumin and serum transferrin with anthropometrics measures.

As regard the nutritional requirements and the actual intake of calories in the two studied groups; in group I the mean of the total caloric need was 2057.21±304.13, the mean of CHO need 1234.33±182.48 Kcal/day, the mean of protein need 514.302±76.032 Kcal/day and the mean of fat need 308.582±45.62 Kcal/day, While the mean % of adequacy of the total caloric intake, through the enteral route throughout the 14 days of admission was 74.72±14.49%, the mean % of adequacy of the CHO intake was 59.30±3.97, the mean % of adequacy of the protein intake was 15.94±7.73%, and the mean % of adequacy of the fat intake was 24.86±5.36%.

While in group II; the mean of the total caloric need 2168.11±367.76, the mean of CHO need 1300.86±220.65 Kcal/day, the mean of protein need 542.027±91.94 Kcal/day and the mean of fat need 325.216±55.164 Kcal/day, while the mean % of adequacy of the caloric intake, throughout the 14 days of admission, through the enteral route was 42.39±14.49%, and through the parenteral route was 58.22±8.54%, the mean % of adequacy of the CHO intake through enteral route was 58.04±8.98% and from the parenteral route was 54.86±12.66%, mean % of adequacy of the protein intake through enteral route was 25.69±5.99% and from the parenteral route 58.22±8.54% and mean % of adequacy of the fat intake was 13.24±2.93 and from parenteral route was 13.09±3.29%.

Patients of group I couldn't receive their full nutritional requirements though enteral route alone while patients in group II received their full caloric and nutritional requirements through the enteral route

complemented by the parenteral route. This coincides with Heidegger *et al.,* [42] who found in his study that supplemental PN combined with EN could be an effective alternative to achieve 100% of energy and protein targets at day 4, when EN alone fails to achieve goals greater than 60% by day 3and also coincides with Pichard *et al.,* [43] Supplementation of insufficient enteral nutrition with parenteral nutrition to critically ill patients, who are frequently hypermetabolic may optimize nutritional support and avert negative energy balance in critically ill patients, thereby improving outcomes. And coincides with Heyland *et al.,* [44] whose study showed that provision of higher amounts of calories by the parenteral route (as the tolerance to enteral feeding is the commonest limiting factor) is thought to be associated with an improved outcome.

**Conclusion**

Anthropometric measurements are good indicators for elderly nutritional status. Pre-albumin level is well correlated with the nutritional status of elderly patient. Pre-albumin level can be used as a marker for early detection of malnutrition and acute changes in the nutritional status while albumin level, if used, should be used for chronic malnutrition. Pre-albumin and albumin levels are well correlated to GNRI. There is no correlation between APACHE II score and pre-albumin level. Nutrition supplied through the combined entero-parenteral route improved the nutritional status of critically ill elderly patient more than enteral route alone.

**References**


1. Visvanathan R. Under-nutrition in older people: a serious and growing global problem. J Postgrad Med 2003; 49:352-60.
2. Pearson JM, Schlettwein GD, Brzozowska A, van Staveren WA, Bjornsbo K. Life style characteristics associated with nutritional risk in elderly subjects aged 80–85 years. J Nutr Health Aging 2001; 5:278-83.
3. Thomas DR, Zdrowski CD, Wilson MM, Conright KC, Lewis C, Tariq S, *et al.* Malnutrition in subacute care. Am J Clin Nutr 2002; 75:308-13.
4. Kagansky N, Berner Y, Koren-Morag N, Perelman L, Knobler H, Levy S. Poor nutritional habits are predictors of poor outcome in very old hospitalized patients. American Society for Clinical Nutrition, Am J ClinNutr 2005; 4:784-91.
5. Griffiths RD, Bongers T. Nutrition support for patients in the intensive care unit. Postgrad Med J 2005; 81:629-36.
6. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med 1985; 13:818-29.
7. Alberda C, Gramlich L, Jones N, Jeejeebhoy K, Day AG, Dhaliwal R, et al. The relationship between nutritional intake and clinical outcomes in critically ill patients: results of an international multicenter observational study. Intensive Care Medicine 2009; 10:1728-37.
8. Sakineh NS, Türkan KM, Peyman M, Yenar. Assessment of the nutritional status and affecting factors elderly people living at nursering home in Urmia, Iran. International journal of academic research 2011;3:234-40.
9. Foley NC, Salter KL, Robertson J, Teasell RW, Woodbury MG. Which reported estimate of the prevalence of malnutrition after stroke is valid? Stroke. 2009;40:66-74.
10. Michael PC, Greet H, Alexander W and Greet VDB. Impact of early parenteral nutrition completing enteral nutrition in adult critically ill patients. EPaNIC 2007 Clinical study no.: S50404.
11. Martindale RG, Mcclave SA, Vanek VW, McCarthy M, Roberts P, Taylor B, *et al.* Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient. Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition, Crit Care Med 2009; 37: 1757-61.
12. Singer P, Berger MM, Van den Berghe G, Biolo G, Calder P, Forbes A, *et al.* ESPEN Guidelines on Parenteral Nutrition: intensive care. ClinNutr 2009;28:387-400.
13. Daly LE, Bourke GJ, Bourke GJ. Interpretation and uses of medical statistics. 5th ed. Oxford ; Malden, MA: Blackwell Science; 2000. xiii, 568 p. p.
14. Kirkpatrick LA, Feeney BC. A simple guide to IBM SPSS statistics for versions 18.0 & 19.0. Australia ; Belmont, CA: Wadsworth; 2012. x, 115 p. p.
15. Olsen JA, Kvamme JM, Florholmen J, Jacobsen BK. Risk of malnutrition and health-related quality of life in community-living elderly men and women: The Tromsø study. Qual Life Res 2011; 20:575–82.
16. Gracia M. Ruby D. Is Gender an Issue in Malnutrition by Anthropometric Indices. Food and Nutrition Research and institute. 2008; 14: 837-8.
17. Nihtilä EK, Martikainen PT, Koskinen SV, Reunanen AR, Noro AM, Häkkinen UT. Chronic conditions and the risk of long-term institutionalization among older people. Eur J Public Health 2008; 18:77-84.
18. Hickson M. Malnutrition and ageing. Postgrad Med J 2006; 82:2–8.
19. Shetty P. Measures of nutritional status from anthropometric survey data. FAO, 2003.
20. Hickson M, Frost G. A comparison of three methods for estimating height in the acutely ill elderly population. J Hum Nutr Diet 2003; 16:13-20.

21. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. Clinical Nutrition 2003; 22:321-36.
22. Drescher T, Singler K, Ulrich A *et al.* Comparison of two malnutrition risk screening methods (MNA and NRS 2002) and their association with markers of protein malnutrition in geriatric hospitalized patients. European Journal of Clinical Nutrition 2010; 64:887–93.
23. Kaiser MJ, Bauer JM, Sieber CC. Evaluation of nutritional status in older persons: Nutritional screening and assessment. CurrOpin Clin Nutr Metab Care 2010;13:8-13.
24. Bouillanne O, Morineau G, Nicolis I, Dupont C, Coulombel I, Vincent JP, *et al.* GNRI, A new index for evaluating at risk elderly medical patients. AM J Clin Nutr 2004;82: 777-83.
25. Buzby GP, Knox LS, Crosby LO, *et al.* Study protocol: a randomized clinical trial of total parenteral nutrition in malnourished surgical patients. Am J Clin Nutr 1988; 47:366–81.
26. Metheny NA, Schallom L, *et al.* Gastric residual volume and aspiration in critically ill patients receiving gastric feedings. Am J Crit Care 2008; 17:512-20.
27. Feinberg MJ, Knebl J, Tully J. Prandial aspiration and pneumonia in an elderly population followed over 3 years. Dysphagia 1996; 11:104-9.
28. Gramlich L, Kichian K, Pinilla J, Rodych NJ, Dhaliwal R, Heyland DK. Does enteral nutrition compared to parenteral nutrition result in better outcomes in critically ill adult patients? A systematic review of the literature. Nutrition J 2004; 20:843-8.
29. Sullivan DH, Sun S, Walls RC. Protein energy under-nutrition among elderly hospitalized patients: a prospective study. JAMA 1999; 281:2013–9.
30. Lopez-Hellin J, Baena-Fustegueras JA, Schwartz-Riera S, Garcia-Arumi E. Usefulness of short-lived proteins as nutritional indicators surgical patients. ClinNutr 2002; 21:119-125.
31. Bauer P, Charpentier C, Bouchet C, Nace L, Raffy F, Gaconnet N. Parenteral with enteral nutrition in the critically ill. Intens Care Med 2000; 26:893-900.
32. Nagata S, Fukuzawa K, Iwashita Y, Kabashima A, Kinoshita T, Wakasugi K, *et al.* Comparison of enteral nutrition with combined enteral and parenteral nutrition in post-pancreaticoduodenectomy patients. Nutrition Journal 2009; 8:24.
33. Lee JS, Choia HS, Ko YG, Yun DH. Performance of the Geriatric Nutritional Risk Index in predicting 28-day hospital mortality in older adult patients with sepsis. Clin Nutrition 2013; S0261-5614(13)00031-9.
34. Yap FH, Joynt GM, Buckley TA, Wong EL. Association of serum albumin and mortality risk in critically ill patients. Anaesth Intensive care 2002; 30:202-7.
35. J. Lee, MH Kim, YJ Lee. Comparison of nutritional indexes including Pre-albumin and severity of scoring systems as prognostic indicators in surgical intensive care unit patients. Yonsei Med J 2005; 1:21-6.
36. V Cerny, P Zivny, P Dostal, R Parizkova. Selected biochemical values and organ dysfunction assessment in prediction of difficult to wean patients. Critical Care 2000; 4:112.
37. Sungurtekin H, Sungurtekin U, Oner O, Okke D. Nutrition assessment in critically ill patients. Nutr ClinPract 2008; 23:635-41
38. Bouillanne O, Morineau G, Nicolis I, Dupont C, Coulombel I, Vincent JP, *et al.* GNRI, A new index for evaluating at risk elderly medical patients. AM J ClinNutr 2004;82: 777-83.
39. Soleymanian T, Ghods A. The deleterious effect of metabolic acidosis on nutritional status of hemodialysis patients. Saudi J Kidney Dis Transpl 2011; 22:1149-54.
40. Cereda E, Limonta D, Pusani C, Vanotti A. The Association of Geriatric Nutritional Risk Index and Total Lymphocyte Count with Short-Term Nutrition. Journal of the American College of Nutrition 2008; 27:406-13.
41. Yovita H, Djumhana A, Abdurachman SA, Saketi JR. Correlation between anthropometrics measurements, prealbumin level and transferrin serum with Child-Pugh classification in evaluating nutritional status of liver cirrhosis patient. Acta Med Indones 2004; 36:197-201.
42. Heidegger CP, Romand JA, Treggiari MM, Pichard C. Is it now time to promote mixed enteral and parenteral nutrition for the critically ill patient. Intensive Care Med. 2007; 33:963-9.
43. Pichard C, Genton L, Heidegger CP, Thibault R. Enteral and parenteral nutrition for critically ill patients: A logical combination to optimize nutritional support. Clinical Nutrition Supplements 2009; 4:3-7.
44. Heyland DK, Gramlich L, Cahill NE, Wang M, Day AG, Dhaliwal R. Early use of supplemental parenteral nutrition in critically ill patients: results of an international multicenter observational study. Crit Care Med 2011; 39:2691-9.