



# Malnutrition Indicators Which is More Predictive? Nutrition Risk Index (NRI) or Malnutrition Universal Screening Tool (MUST)

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### Abstract

**Background:** Traumatic brain injury (TBI) is a major cause of disability, death and economic cost. Malnutrition is one of the common factors at the time hospital admission and tends to worsen during hospitalization, among TBI.

**Methods:** This study was conducted in an outpatient neurosurgery clinic at Khoula Hospital (National Trauma Center)–Muscat–Oman. 77 TBI adult patients, aged 18-65 years, males and females were included in this study. Patients were invited to participate in an anonymous survey. This invitation was extended during routine outpatient visits.

**Results:** The majority of patients were males (85.9%) with 6.1:1 male to female ratio. Most of the patients (75%) were aged between 18-30. 46.5% of subjects were classified as mild TBI while 12.7% and 40.8% were classified as moderate and severe TBI respectively using Glasgow Coma Scale. Motor vehicle accidents were the most common cause of TBI (91.7%), followed by falls from height (8.3%), (28.1%) of patients were underweight BMI<18.5 kg/m<sup>2</sup> while (16.9%) and (7.1%) were overweight and obese respectively.

**Conclusion:** NRI is more predictive malnutrition assessment tool than MUST in TBI patients. The higher sensitivities of NRI (92.9%) mean it is the better screening tool because there is a possibility that only 5%-7% of patients who may be malnourished were not correctly identified. Early recognition and management may help decrease hospital lengths of stay, readmission rates and associated healthcare costs.

### Keywords

Malnutrition; Nutrition risk index; Malnutrition Universal screening tool; Traumatic brain injury

## Introduction

Malnutrition is a major health problem among admitted patients in hospitals. The prevalence of malnutrition is 23% among hospitalized inpatients [1]. Malnourished patients have increased hospital length of stay (LOS), on average malnourished patients spending 4.5 days

longer in the hospital compared to well-nourished ones and increased readmission rates and are more likely to be discharged to a long term care or rehabilitation facility [2].

The increased hospital length of stay can triple healthcare costs from \$9,485 for the average hospitalized patient to \$26,944 for malnourished ones [3]. In developing countries malnutrition is reported to be the leading cause of disease burden with high morbidity and mortality rates. Malnutrition and its implications have been documented in hospitalized patients by Butterworth [4]. 30%-50% of hospitalized patients are described as malnourished or at a risk of malnutrition, in North America [5-7].

Poor nutritional status is positively related with impaired wound healing, increased post-operative complications and mortality [8-10]. To explore the association between malnutrition and various chronic diseases such as cancer, infections and chronic kidney diseases [11-16]. Several studies have been carried out. It showed a relationship between the length of hospital stay and nutritional status.

Traumatic brain injury (TBI) is a major cause of disability, death and economic cost [17,18]. TBI induces inflammatory and hormonal responses that increase the metabolic processes and alter nutrition requirements. Following TBI, the increased energy expenditure and nitrogen excretion mandates adequate nutritional support to provide the optimal milieu for neurological and systemic recovery [19-21]. The hypermetabolic nature of post-traumatic brain injury state makes adequate nutritional support critical. Maintenance of adequate nutritional intake has been shown to have a significant impact on outcomes after TBI [22]. Inadequate nutrition support for TBI patients may result in malnutrition and muscle wasting [23]. This cachexia increases the duration of rehabilitation and length of hospitalization, increases difficulties in mobility, functional rehabilitation, and promoted the development and exacerbation of medical complications [24], as well as neurobehavioral impairments.

To prevent the catabolic state and muscle protein breakdown as a result of increased energy demands, accurate assessment and estimation of the energy and protein needs of TBI patients are a critical component in nutritional treatment and support. With multiple injuries, hyper metabolism increases in a variable degree, and some studies have reported that the mean resting metabolic rate increases by 117%-175% of the healthy resting rate [25-27]. After 2-3 weeks of injury, 120%-145% of energy expenditure is required for TBI patients [28-32]. Furthermore, it was reported that adequate calories intake are essential for reducing sequelae of TBI [33]. Early identification of malnutrition is important to improving outcomes and overall nutritional status of patients [34]. Traditional measures of nutrition status such as laboratory (i.e. serum albumin and prealbumin) and anthropometric measures (i.e. body mass index and percentage weight loss) are beneficial in identifying malnutrition; however, they are not enough and can delay the recognition of malnutrition, especially in TBI patients [34,35].

Two screening tools, the Malnutrition Universal Screening Tool (MUST) and Nutritional Risk Index (NRI), have shown some potential to be reliable methods of evaluating the nutritional status of TBI patients. The Nutritional Risk Index (NRI) [36], is an

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assessment tool uses objective measurements (serum albumin and percent usual body weight) rather than subjective measurements to determine nutritional risk in hospitalized patient populations [37,38]. It has been successfully modified from its original form to be used in various patient groups [38]. The NRI was originally derived from the serum albumin concentration and the ratio of present to usual weight. The NRI uses objective measurements to calculate a score from the following formula:  $(1.519 \times \text{serum albumin} + 41.7 \times \text{current weight} / \text{usual body weight})$  [39]. From NRI values, we defined four grades of nutrition-related risk: (i) severe risk (NRI<83.5); (ii) moderate risk (NRI 83.5-97.5); (iii) mild risk (NRI 97.5-100); (iv) No risk (NRI >100). The NRI cut-off values were determined according to weight losses of 5%, 10% or 20%. The weight loss norms of 5% and 10% have already been validated by the European Society of Parenteral and Enteral Nutrition (ESPEN) Guidelines for Nutritional Screening [40].

Malnutrition Universal Screening Tool, or (MUST) [41], is a screening tool originally developed by the Malnutrition Advisory Group for the British Association of Parenteral and Enteral Nutrition. It has shown strength for application with adult patients across all healthcare settings including TBI [42]. MUST is a five-step screening tool to identify patients who are with no risk, moderate risk and high risk of malnutrition when MUST score was 0, 1 and  $\geq 2$  respectively. One benefit of the MUST tool is that it guides the user to either seek immediate nutrition consultation for high risk patients, or to observe medium risk patients upon hospital admission.

Early recognition of malnutrition by healthcare providers could lead to early intervention, decreased morbidity and mortality, and decreased healthcare costs and LOS [43,44].

The current study aimed to compare between the effectiveness of NRI and MUST as assessment tool to detect malnutrition among TBI patients.

## Methods

The Ethics Committee of our Institution approved this study and patients' written informed consent was obtained (MERC/11/03). This study was conducted in an outpatient neurosurgery clinic at Khoula Hospital (National Trauma Center)-Muscat-Oman. 77 TBI adult patients, aged 18-65 years, males and females were included in this study. Patients were invited to participate in an anonymous survey. This invitation was extended during routine outpatient visits.

The exclusion criterion included: pre-injury psychiatric or neurological history other than those resulting from a TBI, non-Omani patients and those who were known to have cognitive impairments that would preclude completion of the protracted assessment.

## Demographic and anthropometric measures

Demographic information, including age, sex, and education level, marital and smoking status were collected using a structured questionnaire. Weight was measured in kilogram to the nearest 0.1 kg using a digital weighing scale (Seca 208, Vogel and Halke, Germany) Height was measured to the nearest 0.5 cm by using a stadiometer protocol adapted from Lohman et al. [45] with a vertical measuring scale fixed to a metal bar connected to weighing scale. Body Weight (BW) change was calculated as:  $(\text{current BW in kilograms} - \text{ideal BW in kilograms}) / \text{ideal BW} \times 100$ . For patients who were unable to stand, height was estimated by using knee height

equation as " $\text{stature} = 85.10 + 1.73 \times \text{knee height} - 0.11 \times \text{age}$ " for males, " $\text{stature} = 91.45 + 1.53 \times \text{knee height} - 0.16 \times \text{age}$ " for females [46], and by ulna length for males,  $\text{height (cm)} = 4.605U + 1.308A + 28.003$ , and for females,  $\text{height (cm)} = 4.459U + 1.315A + 31.485$  [47], and by demi-span for Males:  $\text{height (cm)} = (1.40 \times \text{demi-span in cm}) + 57.8$  and for Females:  $\text{height (cm)} = (1.35 \times \text{demi-span in cm}) + 60.0$  [48]. The mean height of the three measurements was considered in calculations. Body Mass Index (BMI) was calculated as  $\text{wt. (kg)} / \text{ht. (m}^2\text{)}$ , and the cutoff points of the World health organization were used [49].

## Laboratory measures

Blood samples for serum albumin, and serum creatinine levels were drawn on admission. Albumin was measured by immunonephelometry (normal range 3.5-5.5 g/dL). An albumin level of less than 3.5 g/dL was set as the lower limit of normal in our study [50,51].

## Statistical analysis

Graph Pad Prism (version 6.0) was used for statistical analysis. Means and Standard Deviations (using *t*-tests for two means, one way Anova was used to compare between groups), two sided statistical significance was set at  $\alpha \leq 0.05$  and Proportions were compared by using chi-square test.

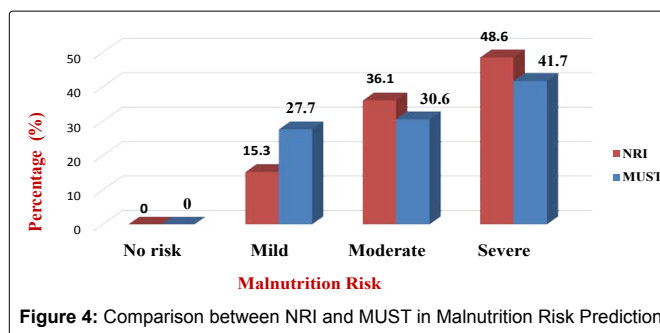
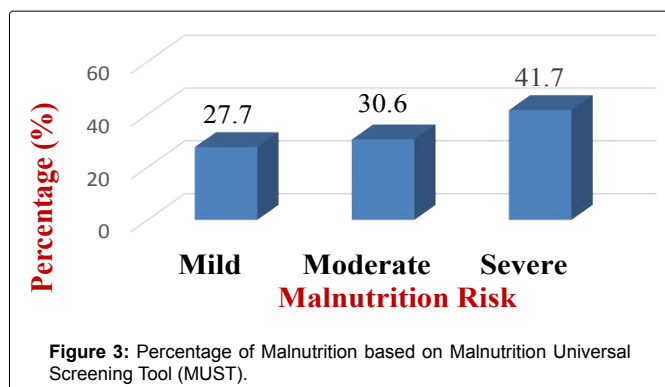
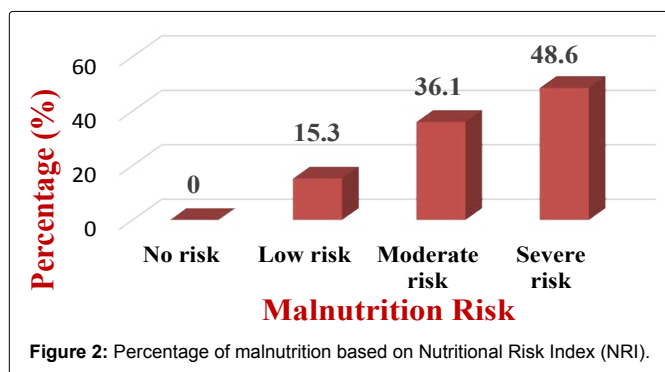
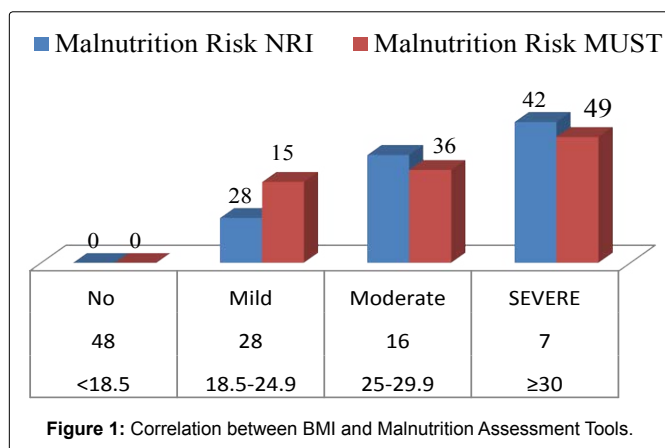
## Results

77 patients in the age group 18-65, with a mean age of 27.3 years that fulfilled the eligibility criteria were enrolled in the study. The majority of patients were males (85.9%) and (14.1%) were females, with 6.1:1 male to female ratio. Most of the patients (75%) were aged between 18-30. 46.5% of subjects were classified as mild TBI while 12.7% and 40.8% were classified as moderate and severe TBI respectively using Glasgow Coma Scale. Motor vehicle accidents were the most common cause of TBI (91.7%), followed by falls from height (8.3%), the most important injuries as a result of fall resulting for fainting among diabetic patients and others with ENT problems results in loss of balance. 28.1% of patients were underweight BMI<18.5 kg/m<sup>2</sup> while (16.9%) and (7.1%) were overweight and obese respectively (Table 1).

Table 1: Demographic and anthropometric characteristics of TBI Patients.

Characteristics	n	%
<b>Gender</b>		
Male	61	85.9
Female	10	14.1
<b>Body Mass Index (kg/m<sup>2</sup>)</b>		
Underweight BMI<18.5	20	28.1
Normal weight BMI 18.5-24.9	34	47.9
Overweight BMI 25-29.9	12	16.9
Obese BMI $\geq 30$	5	7.1
<b>Severity of Trauma (Glasgow Coma Scale)</b>	33	
Mild (GCS $\geq 13$ )	9	46.5
Moderate (GCS 9-12)	29	12.7
Severe (GCS $\leq 8$ )		40.8
<b>TBI cause</b>		
Vehicle accident	71	92.2
Fall from height	6	7.8

Results of the NRI analysis indicated 84.7% were at moderate and severe malnutrition risk, compared with 72.3% detected as severe and moderate risk of malnutrition by using MUST. As expected the BMI values were higher in the No Risk group ( $26.8 \pm 7 \text{ kg/m}^2$ ) as compared to Mild Risk ( $23.7 \pm 4 \text{ kg/m}^2$ ), Moderate Risk ( $21.6 \pm 5 \text{ kg/m}^2$ ) or Severe Risk groups ( $20 \pm 7 \text{ kg/m}^2$ ) with  $P < 0.5$  in both tools (Figure 1). The patients were divided into four groups according to NRI scores identified as No Risk group (n=0), Mild Risk group (15.3%), Moderate Risk group (36.1%) and Severe Risk group (48.6%) (Figure 2). While based on MUST, malnutrition scores identified as mild risk (27.7%), moderate risk (30.6%) and severe risk (41.7%) (Figure 3). Moderate and severe malnutrition were more predicted by NRI compared by MUST (48.6%, 41.7%) and (36.1%, 30.6%) respectively. While mild risk of malnutrition was more predicted by MUST than NRI (27.7%, 15.3%) respectively (Figure 4).



## Discussion

The NRI was developed by the Veterans' Affairs Total Parenteral Nutrition Cooperative Study Group to determine nutritional risk in the postsurgical patient population [52]. The NRI uses the patient's serum albumin, and the ratio of current body weight to ideal body weight to predict a patient's malnutrition status. The score is calculated as follows:  $1.5 \times \text{serum albumin} + 41.7 \times \text{current Weight/ideal body weight}$ . A score of  $>100$  means there is no evidence of malnutrition, 97.5-100 indicates mild malnutrition, 83.5-97.5 means moderate malnutrition, and  $<83.5$  signify severe malnutrition [52]. The MUST was originally developed by the Malnutrition Advisory Group for the British Association of Parenteral and Enteral Nutrition [53]. MUST is a five-step tool that is easy to use and usually takes 3-5 min to complete. It evaluates BMI score, recent weight loss, and acute disease, then assigns an overall numerical risk [53]. A score of 0=low risk, 1=medium risk, and  $\geq 2$ =high risk. Based on the MUST score appropriate management guidelines are provided. A score of 0 requires no intervention. Patients with a score of 1 require close dietary intake monitoring to evaluate for necessary supplements. A score of 2 or more requires immediate nutritional evaluation by a dietitian.

Laboratory values of albumin are useful in identifying malnutrition in the general and TBI populations, but it has a few limitations in their accuracy. Albumin concentrations can be affected by hydration, renal function, and the presence of infection or inflammation [54]. Albumin more accurately identifies chronic malnutrition. Aside from pre albumin and albumin, there is currently a lack of literature that compares other laboratory trends and trends in co-morbidities among malnourished TBI patients. Subjective nutritional screening tools can be easy, rapid and inexpensive methods of identifying malnutrition risk and prevalence among patients.

Our findings showed that NRI is more effective to predict TBI patient's with moderate and severe malnutrition risk (84.7%) compared to MUST (72.3%). These findings are consistency with Al-Najjar and Clark [53] findings, who reported that NRI was a uni-variable predictor of mortality (chi-square 25,  $p < 0.001$ ), and an independent predictor of outcome in multivariable analysis (chi-square 12,  $p < 0.001$ ; [52]. In another study, NRI was found to be the most significant predictor of all-cause mortality and readmission rates [55]. Implementing the use of NRI or MUST on admission for TBI patients may help identify the presence of malnutrition earlier so that the malnourished may be referred to a dietitian for appropriate nutritional intervention earlier.

## Conclusion

NRI is more predictive malnutrition assessment tool than MUST in TBI patients. The higher sensitivities of NRI (92.9%) mean it is the

better screening tool because there is a possibility that only 5%-7% of patients who may be malnourished were not correctly identified. Noting the negative impacts of malnutrition on the patient, early recognition and management may help decrease hospital lengths of stay, readmission rates and associated healthcare costs.

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