Journal of Clinical and Medical Images

Research Article

ISSN: 2640-9615 | Volume 7

Evaluation of Nutritional Status in Critically Ill Patients Using Different Nutritional Screening Tools

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Received: 26 May 2024
Accepted: 01 July 2024
Published: 06 July 2024
J Short Name: JCMI

Citation:

Selim AM, Evaluation of Nutritional Status in Critically Ill Patients Using Different Nutritional Screening Tools. J Clin Med Img. 2024; V7(19): 1-8

1. Abstract

1.1. Introduction: Malnutrition in critically ill patients is a well-recognized nutritional problem and it acts as an important factor in the survival of critically ill patients; Undernutrition results due to decreased intake or increased demand. It is a common problem in intensive care units, high prevalence of malnutrition in ICU patients is associated with the patients' increased morbidity, mortality, and hospital-related cost. Critically ill patients are known to experience hypermetabolism, hypercatabolism and a heightened inflammatory response, which all play a significant part in the development of malnutrition and explain increased prevalence of malnutrition in the ICU. The consequence of malnutrition has serious implications for clinical outcomes.

1.2. Objective: The aim of the study is to Evaluate the incidence of malnutrition among critical ill patients and identifying critically ill patients at risk of malnutrition using different screening tools; NRS-2002 score, MUST score and m-NUTRIC score, and compare the agreement between them and to determine which tools most effectively predicts clinical outcomes in critically ill patients among Egyptian population at Alexandria Hospitals.

1.3. Methods: In this prospective observational study, 360 adult patients were included. The prevalence of malnutrition in ICU was assessed using three different nutritional risk screening tools; MUST score, NRS 2002 score and m-NUTRIC score. Data was collected simultaneously from January 2019 to January 2022 in the different ICUs from Alexandria University Hospital and Health Insurance Hospital, in Alexandria, Egypt.

1.4. Results: The prevalence of malnutrition on admission according to NRS-2002, m-NUTRIC and MUST score [50, 37.2 and 26.9 %, respectively]. The incidence of malnutrition developed during ICU stay in patients' population according to NRS-2002, MUST and m-NUTRIC score was [19.9, 11.3 and 1.1%, respectively], the moderate agreement was showed only between NRS-2002 score and m-NUTRIC score, the kappa values was [k= 0.489]. Both the NRS-2002 and m-NUTRIC scores were significantly associated with all clinical outcomes [all p <.001].

1.5. Conclusion: The incidence of malnutrition among Egyptian ICU population is high, there was difference in the percent depending on the screening tool used. The NRS-2002 and m-NUTRIC are valid tools for identifying patient at high risk of malnutrition among Egyptian population.

2. Introduction

Malnutrition in critically ill patients is still a well-known nutritional problem. It happens when there is an energy imbalance, In this study, we will talk about undernutrition [1]. Malnutrition is a common problem in hospitals. Patients in the intensive care unit [ICU] are more likely to get sick, die, and cost the hospital more money because of it [2,3]. The Academy of Nutrition and Dietetics [AND] and the American Society for Parenteral and Enteral Nutrition [A.S.P.E.N.] came to a consensus on the definition of malnutrition, which it defined as the occurrence of two or more of the following symptoms: inadequate energy intake, weight loss, loss of muscle mass, subcutaneous fat loss, localised or generalised fluid accumulation, or diminished functional status [4]. It is known that critically ill patients have hypermetabolism, hypercatabolism, and a higher inflammatory response. All of these things explain why malnutrition is more common in the ICU [5,6]. Malnutrition has serious repercussions for clinical outcomes, including the development of infectious complications such as nosocomial infections and non-infectious complications such as slow wound healing, longer hospital stays, increased dependence on ventilators, loss of gut barrier function, high score of Acute Physiological Age and Chronic Health Evaluation II [APACHEII] score, lower serum albumin levels, increase costs, and all-cause mortality [3,7,8]. Critically patients, such as those suffering from trauma, sepsis, or major surgery, are dependent on enough nourishment to keep their metabolisms from going into overdrive. These essential circumstances lead to a disproportional release of cytokines and stress hormones, which disrupt energy and protein metabolism and finally lead to malnourishment [9]. Malnutrition prevalence in the acute hospital setting ranges between 20% and 50%, depending on the patient group and the definition and criteria used to diagnose malnutrition [10,11]. Malnutrition has been called the «skeleton in the closet» because it is often neglected, undetected, and untreated [12,13]. On a cellular level, malnutrition makes it harder for the body to respond to an infection with a strong immune response. This makes it harder to find and treat infections. It also makes them more likely to get pressure ulcers, slows wound healing, makes them more likely to get an infection, makes it harder for their body to absorb nutrients, changes how it regulates temperature, and cause multiorgan failure [14,15]. Malnutrition has been linked to an increased ICU stay time. Prolonged stays were seen for patients brought to the hospital with some degree of malnutrition [16,17]. All ICU patients should be screened when they are admitted, and those who are at a higher risk should then have a detailed assessment of their nutritional status. It is still important to make people aware of undernutrition and to use nutritional measures to help patients get better from their treatments [18]. Screening should be a quick and easy process that can be done by the busy nurses and doctors who are taking care of people in the hospital. ESPEN recommends a number of screening tools that have been proven to work [19].

3. Malnutrition Universal Screening Tool

The MUST is a screening tool that is used a lot to find out if an adult is at risk of malnutrition in all health care settings. [20,21] The tool has a way to measure BMI, how much a person's weight has changed, and if they aren't eating well because of an acute disease state. It puts people into groups based on how likely they are to be malnourished. [22-24] If you have a MUST Score of 2 or more, you are at a high risk of malnutrition.

4. Nutritional Risk Screening 2002

The NRS-2002 score is one of the most common ways hospitals all over the world check for nutritional risks [3]. It is a simple, well-tested tool, a screening is done that includes surrogate events of nutritional status, static and dynamic parameters, and information about how bad the disease is [stress metabolism]. For each parameter, you can get a score between 0 and 3. Age over 70 is thought to be a risk factor, and the screening tool gives 1 point for that. If the patient's total score is more than 4, it means that they are at risk of malnutrition or are already malnourished. This means that they need a nutritional therapy [25].

5. The Modified Nutrition Risk in the Critically Ill score

The m-NUTRIC score was proposed as an appropriate nutritinal assessment tool in critically ill patients, but has not been fully demonstrated and widely used. It included age, the Acute Physiology and Chronic Health Evaluation II [APACHE II], the Sequential Organ Failure Assessment [SOFA] score, comorbidities and days from hospitalization to ICU. Patients are scored from 0-9 a score of 5 or greater indicates a high nutritional risk [26].

6. Materials and Methods

6.1. Study Subjects

After approval of the medical ethics committee of Alexandria Faculty of medicine, The study was carried out on 360 patients admitted to ICU in the Critical Care Department of Alexandria University Hospital and Alexandria Health Insurance Hospitals.

6.2. Inclusion Criteria

All critical ill patients aged above 18 years old admitted to intensive care units.

6.3. Exclusion Criteria

Pregnant females and Women with breast feeding, Patients aged 18 or less.

6.4. Methods

Every patient who was part of the study was subjected to Information about the whole [Age, Gender, comorbidities, ICU admission and discharge date and Reason for ICU admission].

Physical examination was done, focusing on anthropometric measures [height, weight, and BMI], and APACHE II and SOFA scores were figured out. Within 48 hours of being admitted, NRS-2002, m-NUTRIC, and MUST scores were used to check each patient's nutritional states. All patients were checked on every day to assess clinical outcomes, 28-day mortality, LOS in ICU, duration of mechanical ventilation, infectious and non-infectious complications were reported. Laboratory tests were done including s-albumin, CRP and WCC.

7. Results

In this prospective observational study, from a total of 360 critically ill patients consisted in 201 [55.8%] males and 159 [44.2%] females, the mean age of 63.19 ± 14.67 years, with 168 [46.7%] younger than 65 years and 192 [53.3%] older than or equal to 65 years of age. Two or more comorbidities were present in 221 [61.4%] patients, The mutual diagnosis lead to the admission in ICU was neurological disease 83 patients [23.1%], sepsis and septic shock 48 [13.3%], respiratory disease 40 [11.1%], abdominal disease 39 [10.8%]. The mean LOS in ICU was 19.09 [SD 22.11] days and the mean duration of M.V was 15.32 [SD 18.81] days. The overall 28-day mortality was 94 patients [26.1%]. 89 patients [24.7%] readmitted to ICU after discharge during 28 days. The mean of the minimum s albumin values was 3.15 [SD 0.68] and the mean of the maximum CRP and WCC levels were respectively 153.5 [SD 111.3] and 15.46 [SD 6.62]. the majority of cases 216 patients [60%] developed infectious complication,190 patients [52.8%] developed noninfectious complications and 154 patients [42.8%] developed bed sores. Patient outcomes are summarized in (Table 1). The mean APACHE II score was 17.37 [SD 9.87] and the mean SOFA score was 5.61 [SD 4.08] as show in table [1]. Malnutrition was prevalent on admission according to NRS-2002, m-NUTRIC and MUST [50 %, 37.2% and 26.9%, respectively]. The incidence of malnutrition developed during ICU stay in patients' population according to NRS-2002, MUST and m-NUTRIC was [19.9 %, 11.3 % and 1.1%, respectively] (Table 2). The kappa values between the malnutrition screening results according to NRS-2002 and m-NUTRIC showed moderate agreement [k= 0.489], between NRS-2002 and MUST showed poor agreement [k= 0.150] and between m-NUTRIC and MUST showed poor agreement [K=0.036] (Table 3). According to NRS-2002 Significant correlations were found between the NRS-2002 score ≥ 4 and the clinical outcomes. A significant correlation was found for duration of mechanical ventilation the malnourished group has a longer duration mean 18.0 [SD 22.35], a longer LOS in ICU mean24.36 [SD 27.02], a higher rate of developing infectious complication 139 [77.2%], a higher rate of developing non-infectious complication 133 [73.9%], a higher rate of mortality during 28 days 78 [43.3%] and the lowest serum albumen values mean 2.82 ± 0.59. (Table 4).

According to m-NUTRIC, Significant correlations were found between the m-NUTRIC score ≥ 5 and the clinical outcomes. Malnourished group seemed to have a longer duration of mechanical ventilation mean18.06 [SD 22.59], a longer LOS in ICU mean27.49 [SD 30.13], a higher rate of developing infectious complication 101 [75.4%], a higher rate of developing non-infectious complication 133 [73.9%], a higher rate of mortality during 28 days 70 [52.2%]and a lowest s-albumin levels mean 2.71 [SD0.59].(Table 5) According to MUST score, when the group classified as malnourished were analyzed and compared to the well-nourished group, there were no significant associations with any of the clinical consequences measured [P value>0.05]. high MUST score is not associated with longer LOS in ICU, prolonged duration of mechanical ventilation, and 28-day mortality. To predict Mortality within 28 days [n = 94 vs. 266] (Figure 1): Area under the ROC Curve of NRS-2002 score was 0.768 [p<0.001*] with Cut off >3 had an acceptable ability to predict Mortality within 28 days with Sensitivity 82.98 %. AUC of m-NUTRIC score was 0.808 [p<0.001*] with Cut off >4 had an excellent ability to predict Mortality within 28 days with Sensitivity 74.47%. The lowest AUC was found in the MUST was 0.552 [p 0.135]

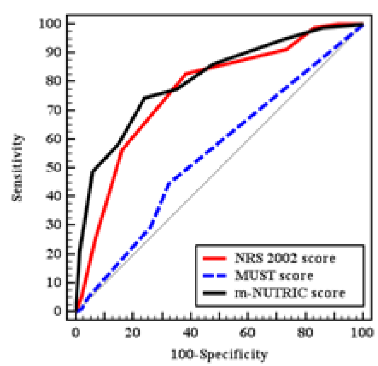

Figure 1: Receiver operating characteristic (ROC) curve for m-NUTRIC, NRS-2002, and MUST for predicting 28-day mortality.

Table 1: Distribution of the studied cases according to summary of clinical outcome observed in patients' populations (n = 360)

Clinical Outcome	**%**
Readmission after ICU discharge during 28 days	89 (24.7%)
Mortality within 28 days	94 (26.1%)
Infectious complication	216 (60.0%)
Non-Infectious complications	190 (52.8%)
Duration of mechanical ventilation (n=171)	
Min. – Max.	1.0 – 120.0
Mean ± SD.	15.32 ± 18.81
Length of stay in ICU	
Min. – Max.	2.0 – 183.0
Mean ± SD.	19.09 ± 22.11
Minimum serum albumin	
Min. – Max.	1.90 – 4.20
Mean ± SD.	3.15 ± 0.68
Highest WBCs	
Min. – Max.	3.0 – 50.0
Mean ± SD.	15.46 ± 6.62
Highest CRP	
Min. – Max.	3.0 – 490.0
Mean ± SD.	153.5 ± 111.3
APACHE II score	
Min. – Max.	0.0 – 44.0
Mean ± SD.	17.37 ± 9.87
SOFA score	
Min. – Max.	0.0 – 16.0
Mean ± SD.	5.61 ± 4.08

SD: Standard Deviation

Table 2: Distribution of the studied cases according to nutritional status on admission using NRSTs (n = 360)

	Well Nourished		Malnourished	
	No.	%	No.	%
Nutrition states				
NRS 2002 score	180	50	180	50
MUST score	263	73.1	97	26.9
m-NUTRIC score	226	62.8	134	37.2

Table 3: Agreement between the three screening tools

	Agreement (%)	**κstatistic**
NRS 2002 – m-NUTRIC	37.2	0.489
NRS 2002 - MUST	26.9	0.15
m-NUTRIC - MUST	26.9	0.036

κ: kappa test

Table 4: Relation between NRS 2002 score on admission with summary of clinical outcome observed in patients' populations (n = 360)

	NRS 2002 score		**Test of Sig.**	**P**
	Well nourished (n = 180)	Malnourished (n = 180)		
Readmission after ICU discharge during 28 days	19 (10.6%)	70 (38.9%)	χ2=38.823*	<0.001*
Mortality within 28 days	16 (8.9%)	78 (43.3%)	χ2=55.345*	<0.001*
Infectious complications	77 (42.8%)	139 (77.2%)	χ2=44.491*	<0.001*
Non-Infectious complications	57 (31.7%)	133 (73.9%)	χ2=64.376*	<0.001*
Duration of mechanical ventilation#				
Mean ± SD.	10.49 ± 7.60	18.0 ± 22.35	U= 2606.5*	0.016*
Median (Min. – Max.)	8.0 (2.0 – 32.0)	11.0 (1.0 – 120.0)		
Length of stay in ICU				
Mean ± SD.	13.82 ± 13.95	24.36 ± 27.02	U= 9102.5*	<0.001*
Median (Min. – Max.)	7.0 (2.0 – 73.0)	17.0 (4.0 – 183.0)		
Serum Albumin				
Mean ± SD.	3.47 ± 0.60	2.82 ± 0.59	t= 10.368*	<0.001*
Median (Min. – Max.)	3.60 (1.90 – 4.20)	2.90 (1.90 – 4.20)		

SD: Standard deviation t: Student t-test U: Mann Whitney test χ2:Chi square test

p: p value for comparing between Well-nourished and Malnourished*: Statistically significant at $p \leq 0.05$

#: Length of mechanical ventilation done for 171 cases, in well-nourished was 61 and in Malnourished was 110

Table 5: Relation between m-NUTRIC score on admission with summary of clinical outcome observed in patients' populations (n = 360)

	m-NUTRIC score		**Test of Sig.**	**P**
	Wellnourished(n=226)	Malnourished(n=134)		
Readmission after ICU discharge during 28 days	38 (16.8%)	51 (38.1%)	χ2=20.403*	<0.001*
Mortality within 28 days	24 (10.6%)	70 (52.2%)	χ2=75.526*	<0.001*
Infectious complications	115 (50.9%)	101 (75.4%)	χ2=21.019*	<0.001*
Non-Infectious complications	82 (36.3%)	108 (80.6%)	χ2=66.281*	<0.001*
Duration of mechanical ventilation#				
Mean ± SD.	10.63 ± 7.38	18.06 ± 22.59	U= 2771.0*	0.043*
Median (Min. – Max.)	9.0 (1.0 – 28.0)	11.0 (3.0 – 120.0)		
Length of stay in ICU				
Mean ± SD.	14.11 ± 13.29	27.49 ± 30.13	U= 7862.5*	<0.001*
Median (Min. – Max.)	8.0 (2.0 – 69.0)	19.50 (5.0 – 183.0)		
Serum Albumin				
Mean ± SD.	3.41 ± 0.58	2.71 ± 0.59	t= 11.022*	<0.001*
Median (Min. – Max.)	3.40 (1.90 – 4.20)	2.60 (1.90 – 4.20)		

8. Discussion

In this study, 55.8% of the people who were studied were men and 44.2% were women. The average age was 63.19 ±14.67 years, with 168 people [46.7%] younger than 65 and 192 people [53.3%] older than or the same age as 65. 221 of the patients [61.4%], had two or more comorbidities. Neurological disease was the most common reason for admission to the ICU 83 patients [23.1%], followed by sepsis and septic shock 48 patients [13.3%], respiratory disease 40 patients [11.1%], abdominal disease 39 patients [10.8%], post-operative elective and emergency surgery 31 patients [8.6%] and 12 [3.3%], renal disease 30 patients [8.3%], cardiovascular disease 22 patients [6.1%], haematological disease 13 patients [3.6%], and other medical 23 patients [6.4 %]. Most of the people who were studied have a BMI of more than 30 [37.5%], while only 9.4% have a BMI of less than 18.5. In agreement with our study, Majari et al. [27], which looked at critically ill patients admitted to the

ICU, found that the average age of the patients was 60 ±19.2 years, and that 58% of the patients were men. Canales et al [28] looked at the risk of malnutrition in very sick people and found that the average age was 61 ±17 years and the average BMI was 28.7 kg/m2. Kenworthy et al [29] found that 71 percent of critically ill patients have comorbidities: 15% have neurological problems, 13% have trauma, 11% have sepsis, 10% have cardiovascular problems, and 7% have breathing problems. Al-Kalaldehet al [30]. showed that when critically ill patients were admitted to the ICU, 32.4% of the diagnoses were neurological, 28.3% were respiratory, 14% were cardiovascular, 10.9% were trauma, 5.6% were gastrointestinal, and 6.2% were sepsis.

Our results showed that a high risk of malnutrition at admission based on the NRS-2002, m-NUTRIC, and MUST nutrition-risk screening tools was 50, 37.2, 26.9 percent respectively. In a similar way, Marchetti et al [31]. who looked at malnutrition in critically ill patients, found that 55 percent of critically ill patients were at high nutritional risk, according to NRS-2002, and 36.5 percent were at high nutritional risk, according to NUTRIC. Our results showed that the kappa values between the malnutrition screening results from NRS-2002 and m-NUTRIC were moderate [k=0.489], while the values between NRS-2002 and MUST, and the values between m-NUTRIC and MUST were poor. In the same way, Egan et al [32] found that m-NUTRIC and MUST do not agree with each other. Corujaet al [33] found that comparing the NRS 2002 and m-NUTRIC nutrition screening tools in the ICU showed fair agreement [κ = 0.39]. The relationship between the NRS 2002 score on admission and the Acute APACHE II and SOFA scores showed that both APACHE II and SOFA scores went up in the malnourished group [P value<0.001].The m-NUTRIC score showed the same results [P value<0.001], and the MUST score didn't show any statistically significant differences between the patients who were looked at [P value > 0.05].

According to m-NUTRIC, Significant correlations were found between the m-NUTRIC score ≥5 and the clinical outcomes. Malnourished [high m-NUTRIC score] group seemed to have a higher 28-day mortality. AUC of m-NUTRIC score was 0.808 [p<0.001*] with Cut off >4 had an excellent ability to predict Mortality within 28 days patients with Sensitivity 74.47%. According to NRS-2002 Significant correlations were found to predict Mortality within 28 days patients [n = 94 vs. 266]: AUC of NRS 2002 score was 0.768 [p<0.001*] with Cut off >3 had an acceptable ability to predict Mortality within 28 days patients with Sensitivity 82.98 %. These results back up what dos Reis et al. [34] found, which was that the m-NUTRIC and NRS-2002 scores were about the same at predicting hospital mortality among critically ill patients. Also, Similarly, Kalaiselvanet al [35] indicated that patients with high m-NUTRIC score ≥5 had higher APACHE II and SOFA scores [27.7±6.0; 8.7±2.8, respectively] compared to patients with low m-NUTRIC score [19.0±6.1; 5.5±2.5, respectively] and that The PPV and the NPV of m-NUTRIC score to predict mortality were 47.4% and 68.9%, respectively, with a sensitivity and specificity of 41.5% and 73.8%. Concerning the nutrition-risk screening tools' [NRSTs] predictions of clinical outcomes, correlations between the NRS-2002 score of ≥ 4, the m-NUTRIC score ≥ 5 and the clinical outcomes were found to be significant. The mean LOV and LOS in ICU of the malnourished group were much longer than those of the well-nourished group. The malnourished group also had a higher death rate, more infectious and non-infectious complications, lower s-albumin levels, and higher CRP and WCC levels than the well-nourished group [P value<0.001].

According to NRS 2002 score in present study to predict length of stay ≥14 day [n = 181 vs. 179]: AUC of NRS 2002 score was 0.710 [p<0.001*] with Cut off >3 had an acceptable ability to predict length of stay ≥14 day with Sensitivity 67.40 %. And to predict developing of infectious complication; AUC of NRS 2002 score was 0.715 [p<0.001*] with Cut off >3 had an acceptable ability to predict developing of infection with Sensitivity 64.35%. and to predict developing of non-infectious complication; AUC of NRS 2002 score was 0.737 [p<0.001*] with Cut off >3 had an acceptable ability to predict developing of non-infectious complication with Sensitivity 64.35%. These findings are in agreement with those of Auiwattanakulet al [36] who investigated critically ill patients admitted to an intensive care unit and assessed the effects of nutrition hazard on the occurrence of sepsis and mortality. They found that nutrition risk screened by NRS-2002 [score ≥4] was significantly associated with death and septic shock. Based on m-NUTRIC score, significant correlations were found between the m-NUTRIC score ≥ 5 and the clinical outcomes. The malnourished group had a significantly longer mean LOV [18.06± 22.59] than the well-nourished group mean LOV [10.63 ±7.38] [p=0.043]. The malnourished group has a longer LOS [27.49± 30.13], and higher 28-day mortality [70%], more infectious and noninfectious complication [75.4% and 80.6% respectively], lower s-albumin levels and higher CRP and WCC levels than the group well-nourished [P value<0.001].

In present study malnourished [high m-NUTRIC score] group seemed to have a higher 28-day mortality. AUC of m-NUTRIC score was 0.808 [p<0.001*] with Cut off >4 had an excellent ability to predict Mortality within 28 days patients with Sensitivity 74.47%. To predict length of stay ≥14 day [n = 181 vs. 179]: AUC of m-NUTRIC score was 0.710 [p<0.001*] with Cut off >3 had an acceptable ability to predict length of stay ≥14 day with Sensitivity 64.64%. m-NUTRIC score had no ability to predict length of mechanical ventilation ≥10 day [n = 86 vs. 85]. To predict developing of infectious complication AUC of m-NUTRIC score was 0.660 [p<0.001*] with Cut off >3 had an acceptable ability to predict developing of infection with Sensitivity 56.94%. And to predict developing of non-infectious complication; AUC of m-NUTRIC score was 0.757 [p<0.001*] with Cut off >3 had an acceptable ability to predict developing of non-infectious complication with Sensitivity 56.94%.

As Wang et al [37] have shown, patients admitted to the ICU are at high risk of malnutrition, and a high mNUTRIC score is linked to a longer time in the ICU and a greater mortality rate.

Additionally, Mendes et al [38] indicated that high m-NUTRIC score was statistically associated with longer LOS and higher 28-day mortality. The AUC of NUTRIC score ≥5 for expecting 28-day mortality was 0.658 [95% CI, 0.620-0.696]. NUTRIC score ≥5 had a positive predictive value 32.7% and a negative predictive value 88.8% for 28-day mortality. According to the findings of this research, the NRS-2002 may be superior than the m-NUTRIC, and both may be superior to the MUST when it comes to screening for nutrition risk in Egyptian intensive care unit populations. There appears to be some sort of level of agreement between m-NUTRIC and NRS 2002 in screening out those patients who have high risk and low risk of malnutrition. The NRS 2002 seems to screen out more patients who are at risk for malnutrition than the other tools do. We were able to show that the use of MUST was not successful in identifying patients in the ICU who were at risk of malnutrition.

9. Limitations of the Study

This was an observational non-invasive study; it couldn't prove the clinical benefit of screening ICU patients. MUST and NRS 2002 data about weight loss and food intake were poorly available in-patient files and ICU patients usually not being able to communicate effectively due to sedation, coma, confusion or mechanical ventilation.

10. Conclusion

The incidence of malnutrition among Egyptian ICU population is very high so early identification of critically ill patients at high risk of malnourished is very important. There was difference in the percent of patients identified as high risk of malnutrition depending on the screening tool used. NRS-2002 is superior to m-NUTRIC for assessing malnutrition risk in ICU patients. The NRS-2002 and m-NUTRIC are easy to apply They show moderate agreement in screening out those patients with high risk and low risk of malnutrition. The m- NUTRIC is superior to NRS 2002 for predicting unfavorable outcomes; increase ICU LOS, 28-day mortality and developed of infectious and non-infectious complications among studied population. The use of MUST is failed to identify patients who at high risk of malnutrition, and could not effectively predict clinical outcomes in malnourished groups in ICU patients.

11. Statement of Interest

None declared.

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