

Selection of an Acceptable Method of Evaluating Nutritional Status in Hemodialysis Patients Compared to Subjective Global Assessment: A Cross-Sectional Study

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Abstract

Background: Protein-energy wasting (PEW) is prevalent among hemodialysis (HD) patients and is associated with poor outcomes. There are various methods for evaluating nutritional status in HD patients that each has its own advantages and disadvantages. We aimed at comparing the methods of normalized protein catabolic ratio (nPCR) and malnutrition universal screening tool (MUST) with subjective global assessment (SGA) in HD patients.

Method: We examined 88 HD patients using SGA and MUST questionnaires, and also nPCR were calculated using predialysis and post-dialysis BUN, and Kt/v. Also, patients were assessed for PEW based on the Criteria of the International Society of Renal Nutrition and Metabolism. Methods' specificity, sensitivity, and precision rates were assessed. Correlations between methods were analyzed using Pearson-correlation.

Results: Based on the SGA, MUST, and nPCR methods, almost 41, 30, and 60 percent of patients had malnutrition, respectively. According to the criteria by International Society of Renal Nutrition and Metabolism, more than 90 percent of patients had PEW. SGA was positively and significantly associated with MUST ($P \leq 0.001$). Sensitivity for SGA, MUST, and nPCR methods were 100, 100, 1.8 %, and their specificity were 98, 98, and 4 %, respectively and their precision rates were 99.7, 98.7, and 3%, respectively.

Conclusion: From various methods of nutritional assessment (SGA, MUST, and nPCR), compared to SGA as the common method of nutrition assessment in hemodialysis patients, MUST had the nearest specificity, sensitivity, and precision rate compared to SGA and nPCR method had the lowest ones. nPCR seems to be a flawed marker of malnutrition and it should be more investigated whether MUST can be used instead of SGA or not.

Background

End stage renal disease patients (ESRD) undergo dialysis as a therapeutic approach. However, their quality of life is poor (1, 2) and they experience various degrees of malnutrition (3–5). Protein-energy wasting is prevalent among HD patients and this can increase the risk of cardiovascular diseases, hospitalization, morbidity, and mortality or in other words it can cause poor outcome (4–6). There are various methods for assessing nutritional status in HD patients. These methods include serum albumin, SGA, anthropometric indices, body composition, skinfold measurements, malnutrition-inflammation score (MIS), and the like (7). Each of these methods has its own advantages or disadvantages, and no standard exists for defining the best method of nutrition assessment in HD patients. For example, assessing the nutritional status of patients using anthropometric indices is a simple and non-invasive method that could have errors related to the measurement accuracy, reliability, or precision by different people or various tools in various times (7) or assessing body composition in HD patients has its own problems due to the water fluctuations or disturbances in this group (8).

A new way for assessing nutritional status in HD patients could be related the use of the protein catabolic rate normalized to dry weight (nPCR) that can help us to monitor nutritional status according to the method related to protein intake (9). Obtaining nPCR would be easier than measuring protein intake in HD patients and even it would be more accurate (10). On the other hand, nPCR is correlated with $KT/V(\text{urea})$ and this shows its clinical importance for considering dialysis dose in assessing protein role and nutrition in HD patients (10). Moreover, nPCR is considered a great predictor outcome in HD patients (10). However, a few studies focused on evaluation of nutritional status in HD patients with nPCR or comparing it with other methods.

Further, easy and quick ways for assessing nutritional status in patients undergoing HD would be of great importance. Two questionnaires are available for assessing nutritional status in adults including malnutrition universal screening tool (MUST) questionnaire and subjective global assessment (SGA). MUST questionnaire can be used in all adult patients in whom weight or height measurements are not possible. In this questionnaire, we can use recalled or surrogate markers of weight, height, or body mass index (BMI) and some subjective criteria as needed (11). On the other hand, SGA questionnaire is an easy and inexpensive way of assessing nutritional status in HD patients. this is a comprehensive, valid, and reliable tool that requires no laboratory evaluation (4). SGA was frequently used in HD patients for nutritional assessment, but still, there is no comparison between the application of MUST and SGA questionnaires in evaluating nutritional status in HD patients in a short time.

As malnutrition is prevalent among HD patients and it can cause poor prognosis, accurate evaluation of nutritional status with appropriate techniques in this group is of great importance. Different methods have been applied for malnutrition evaluation in HD patients. However, there are still some techniques that could be useful in evaluating these patients and they haven't been examined in the previous studies, yet, and some of them are easy and rapid methods that can be used for assessing nutritional status in these patients and we don't know definitely that which one is the superior technique for assessment and whether they are associated or not. Hence, the aim of this study was to compare two methods of evaluating nutritional status (nPCR and MUST) with subjective global assessment (SGA) in HD patients and to assess their association for better assessment of these patients and ensuring adequate intervention in order to reduce poor prognosis, morbidity, and mortality in HD patients.

Method

In this cross-sectional study, a total of 88 patients with ESRD on hemodialysis (HD) were recruited at hemodialysis centers of Shiraz University of Medical Sciences, Shiraz, Iran. The study protocol was reviewed and approved by the Ethics Committee of Shiraz University of Medical Sciences, Shiraz, Iran. The inclusion criteria were as follows: patients aged 17 to 65 years and receiving regular HD. We excluded the patients who received protein supplements or antibiotics currently or recently and those who were hospitalized or had infections within the 2 months prior to recruitment to the study. We screened 300 HD patients and 88 eligible patients were included and they signed the informed consent to participate in this

study. Eligible patients were dialyzed with polysulfone/polyamide membranes, reverse-osmosis purified water, and bicarbonate-containing dialysate at least twice per week.

Sample size was determined according to a similar study assessing malnutrition prevalence considering different methods including SGA (8). A sample size of 88 patients was determined with a P of 0.05 and d of 0.01 at the predetermined level of $\alpha = 0.05$.

At the beginning of the study, after assessing the demographic information of the patients, their nutritional status was assessed using three methods including SGA questionnaire, MUST questionnaire, and nPCR in order to classify the patients according to their nutritional status and compare the methods in assessing the nutritional status of these patients. First of all, SGA questionnaire was completed for each patients as it needs no laboratory measurement. The SGA is a comprehensive method for assessing malnutrition in various diseases including HD. This is an inexpensive and rapid method for assessing nutritional status in patients. No laboratory data is needed and this method is considered a valid tool for assessing nutritional status in hemodialysis patients as it was also used in different studies (4). This questionnaire was previously applied in different studies assessing the nutritional status of HD patients (3, 4). The questionnaire has different parts that assess various features including any changes in weight (during the preceding 6 months and 2 weeks), dietary intake, gastrointestinal problems, functional capacity, and any metabolic demand of the underlying disease were assessed. In the part related to the physical examination, the investigator assessed loss of subcutaneous fat, muscle wasting, and the presence of ankle/sacral edema. Each feature was separately rated as A, B, or C to demonstrate the degree of malnutrition. Then, we converted the SGA ratings to numerical equivalents: a score up to 10 indicates well-nourished; 10 to 17, at risk for malnutrition or mildly to moderately malnourished; and higher than 17 as severely malnourished (3, 4). In the present study, an experienced investigator working regularly with HD patients did the physical examinations needed and completed the SGA questionnaires.

In the next step, MUST questionnaire was completed for each patient by the main investigator. The Iranian version of this questionnaire was previously validated in a another study (12). One part of assessment in MUST questionnaire included calculating body mass index (BMI), hence, at the end of the dialysis session, dry body weight was measured using a digital scale with an accuracy of 0.1 kg while the patients were barefoot and wore lightweight clothes and their height was also measured in erect position via a stadiometer with an accuracy of 0.1 cm. For calculating BMI, body weight (kg) was divided by the height squared (m^2). We also asked about the usual weight of patients in a period of three to six months. Another part was related to the percentage of unintentional weight loss in the previous three to six months and this was calculated from patients' reports. In the next step in MUST questionnaire, acute disease effect was assessed and scored considering dietary intake and the presence of any acute disease, when the patient had any acute disease and has been or was likely to have no nutritional intake for 5 days, she/he would get a score of 2 from this part (11).

According to MUST scoring (Fig. 1), the studied patients were classified into three malnutrition risk categories (low, medium and high) as follows: Patients with the BMI of $< 18.5 \text{ kg/m}^2$ and a history of

unintentional weight loss of > 10% in the last three to six months were considered as high risk for malnutrition; BMI 18.5–20 kg/m² and a history of unintentional weight loss 5% – 10% in the last three to six months as medium risk; and BMI > 20 kg/m² and unintentional weight loss < 5% in the last three to six months were considered as low risk (ie. normal or without malnutrition) (11). Overall, the final scores could classify the patients as low risk, medium risk, or high risk (Fig. 1).

For the last step, we decided to assess the nutritional status of the patients considering nPCR calculation. For calculating nPCR, some laboratory data were needed to calculate it using the following Eq. (13):

$$\text{nPCR} = (0.0136 \times F) + 0.251 \text{ in g/kg per day}$$

Where F is equal to $Kt/V \times ([\text{predialysis BUN} + \text{postdialysis BUN}]/2)$.

For calculating nPCR, pre and post BUN (blood urea nitrogen) and Kt/v were needed and we obtained them with the help of the nurses working with hemodialysis patients for the dialysis procedure. For obtaining pre and post-dialysis BUN, blood samples were taken from each patient before and after the dialysis session.

After centrifugation, serum was separated and stored and BUN was measured for each patient for twice (pre and post dialysis). Then, considering the BUN and Kt/v, the nPCR was calculated for each patient using the aforementioned equation. According to the nomenclature for protein-energy wasting (PEW) proposed by the International Society of Renal Nutrition and Metabolism in 2008, nPCR \leq 0.8 could be considered a criteria for PEW in HD patients (13). In addition, serum albumin of all the patients were recorded from their medical history as it was measured recently at the time of the study. Considering the fact that we obtained serum albumin, nPCR, BMI, and serum Cr for all patients, we also assessed the presence of PEW according to all 4 criteria of the International Society of Renal Nutrition and Metabolism in all patients. These criteria include nPCR \leq 0.8, serum albumin < 3.8 g/dl, BMI < 23 kg/m², and serum Cr < 818 μ mol/L. For assessing PEW, when no criteria was present, PEW were not existent, 1 criteria showed mild PEW, 2 criteria showed moderate PEW, and when 3 or 4 criteria were present, severe PEW were defined (13).

Moreover, we also calculated sensitivity, specificity, and precision for the three methods of assessment (SGA, MUST, and nPCR). Sensitivity is used to assess the strength of a test to detect true positive cases with malnutrition and specificity is used for detecting the true negative cases with malnutrition. Precision is the positive predictive value of a test.

Finally, the data were analyzed using SPSS software, version 22 (SPSS Inc.). Results are reported as percent or frequency for showing the prevalence of malnutrition according to different methods. Sensitivity, specificity, and precision rate for each test are shown in percentage. For comparing malnutrition between different methods, chi-square test was used. For assessing the correlation between different methods, Pearson correlation was used for the normal data and spearman correlation for the skewed data. P < 0.05 was considered significant.

Results

This was a cross-sectional study for assessing malnutrition or PEW in hemodialysis patients considering different methods. 88 patients were analyzed finally. The demographic, nutritional, and biochemical characteristics of the patients are demonstrated in Table 1. The mean age of the HD patients was 44 ± 11 years. As it was mentioned, nutritional status of the patients was assessed using different methods. According to the SGA scores, most of the patients were considered well-nourished (51.9%), while no one had severe malnutrition. On the other hand, considering the evaluations done by MUST questionnaire, most of the patients (69.3%) had low risk considering malnutrition and just some patients (14.8%) had a high risk for malnutrition. Considering $nPCR \leq 0.8$ for assessing malnutrition according to one criterion defined by International Society of Renal Nutrition and Metabolism for PEW, most of the studied HD patients (63.6%) had PEW and others were considered normal. Moreover, we assessed the four criteria of PEW by International Society of Renal Nutrition and Metabolism, and the results considering this assessment showed that most of the patients in the current study had moderate PEW (44.3%) and only 12 patients were severely wasted (severe PEW). However, nine patients (ie. almost 10%) had normal nutritional status (Table 2).

In Table 3, the correlation between three methods of assessing nutritional status (SGA, MUST, and nPCR) was assessed using Pearson correlation and p-values and r for these correlations are reported in Table 3. According to these results, there was a statistically significant positive association between SGA score and MUST score ($P = 0.01$, $R = 0.26$). Moreover, there was a negative association between SGA score and nPCR (Table 3). On the other hand, there was a negative correlation between SGA score and nPCR measure, but this correlation was not statistically significant ($P > 0.5$)

On the other hand, after comparing classifications of nutritional status with various methods with each other using chi-square test, it was demonstrated that classifications made by MUST and SGA questionnaires were significantly different ($P < 0.001$), while those classification done by nPCR and MUST or SGA and nPCR were not significantly different with each-other.

Considering the specificity, sensitivity, and precision analysis, all of the data related to three methods of assessment (SGA, MUST, and nPCR) at their standard cut-offs are presented in Table 4. According to this assessment, in the cut-off used for finding malnourished patients by each method, SGA had the highest sensitivity and specificity (100% and 98%, respectively) and a high precision rate (99.7%), while nPCR had the lowest sensitivity and specificity (1.8% and 4%, respectively) and also a very low precision rate (3%). According to MUST method, it had a high sensitivity and specificity that was similar to SGA, but the precision rate was almost lower than SGA (Table 4).

Table 1
Demographic, biochemical, and nutritional parameters of the study patients

Age (years)[#]	44 ± 11
Sex (female/male) [*]	38/50
Weight (kg) [#]	67.6 ± 16
Height (cm) [#]	166.2 ± 10
BMI (kg/m ²) [#]	24.1 ± 4
Cr (μmol/L) [#]	776.1 ± 228.4
Pre-dialysis BUN (mg/dl) [#]	44.2 ± 12
Post-dialysis BUN [#]	14.6 ± 6
Albumin (g/dl (mg/dl)) [#]	4.1 ± 0.6
Kt/v [#]	1.3 ± 0.3
SGA score [#]	9 ± 2
MUST score [#]	0.7 ± 1.4
nPCR (g/kg/d) [#]	0.75 ± 0.16
<p>[*] Data is shown as frequency; [#] Data are shown as mean ± SD; Abbreviations: BMI: body mass index; Cr: creatinine; BUN: Blood urea nitrogen; SGA: subjective global assessment; MUST: malnutrition-universal screening tool; nPCR: normalized protein catabolic ratio;</p>	

Table 2

Malnutrition prevalence according to different methods in the studied hemodialysis patients

Method for nutritional assessment	Classification	frequency	Percent (%)
SGA	Well-nourished	52	59.1
	Mild or moderate malnutrition	36	40.9
	Severe malnutrition	0	0
	Total	88	100
MUST	Low risk	61	69.3
	Medium risk	14	15.9
	High risk	13	14.8
	Total	88	100
PEW according to nPCR	nPCR \leq 0.8 g/kg/d (PEW)	56	63.6
	nPCR > 0.8 g/kg/d (Normal)	32	36.4
	Total	88	100
PEW according to Criteria of the International Society of Renal Nutrition and Metabolism for PEW*	Normal (no abnormal criteria)	9	10.2
	Mild malnutrition (1 abnormal criteria)	28	31.8
	Moderate PEW (2 abnormal criteria)	39	44.3
	Severe PEW(3 or 4 abnormal criteria)	12	13.6
	Total	88	100

Abbreviations: SGA: subjective global assessment; MUST: malnutrition-universal screening tool; PEW: protein-energy wasting; nPCR: normalized protein catabolic ratio; * These criteria include nPCR \leq 0.8, serum albumin < 3.8 g/dl, BMI < 23 kg/m², and serum Cr < 818 μ mol/L

Table 3

Correlation between different methods used for assessing nutritional status in the studied hemodialysis patients:

Methods	SGA	MUST	nPCR
SGA	-	r = 0.26 P = 0.01	r = - .09 P = 0.4
MUST	r = 0.26 P = 0.01	-	r = 0.049 P = 0.65
nPCR	r = - .09 P = 0.4	r = 0.049 P = 0.65	-

Abbreviations: SGA: subjective global assessment; MUST: malnutrition-universal screening tool; nPCR: normalized protein catabolic ratio;

Table 4

sensitivity, specificity, and precision rate of the malnutrition assessment tools in the study

Assessment tools	Sensitivity (%)	Specificity (%)	Precision rate (%)
SGA	100	98	99.7
MUST	100	98	98.7
nPCR	1.8	4	3

Abbreviations: SGA: subjective global assessment; MUST: malnutrition-universal screening tool; nPCR: normalized protein catabolic ratio;

Discussion

Nutrition assessment is vital in HD patients as malnutrition is associated with poor prognosis and dire consequences regarding higher morbidity or mortality (3–6). There are different methods for assessing nutritional status in HD patients including laboratory, anthropometric, and subjective methods (8). Here we aimed to compare three methods of nutritional assessment including two subjective (SGA and MUST) and one laboratory assessment (nPCR) used for evaluating nutritional assessment in HD patients to assess their efficacy or association.

According to the results of the current study, almost 41% of the studied HD patients had malnutrition (mild or moderate) based on the SGA assessment that is a common and acceptable way of assessing nutritional status in this group, while it was obvious that almost 60% were considered well-nourished according to this assessment. This was in line with the reports by other studies showing more than 40 percent malnutrition in HD patients according to SGA assessment (14–16).

Moreover, another method used in this study for assessing nutritional status in HD patients was MUST questionnaire. This was almost used as a new method in this group and is an easy and quick tool which needs no laboratory measurements or can be applied without directly measuring weight or height by using recalled information (11). According to the assessments done by MUST questionnaire, more than 30 percent of the HD patients in the current study had medium or high risk of malnutrition and it was also shown that there is a positive significant correlation between SGA and MUST score. As we know, in both methods, SGA and MUST, higher scores show poor nutritional status and this positive correlation shows that both methods are in line with each-other in showing nutritional status of patients, but as it was asserted in the result part, their classifications were significantly different which cause hesitate in interpreting the data by MUST as this method is not commonly used for assessing nutritional status in HD patients, while SGA is frequently used for nutritional assessment in these patients. Hence, it seems that using MUST questionnaire for assessing nutritional status in HD patients needs further investigation and the current result regarding nutritional assessment with MUST should be interpreted with caution.

Further, according to the criteria by International Society of Renal Nutrition and Metabolism for PEW (13), almost 76 percent of studied HD patients had mild or moderate PEW and more than 13 percent had severe PEW which means a total of almost 90 percent had PEW according to this classification. Our result considering this classification is in accordance with the results reported by Foucan et.al. that showed more than 70 percent of the HD patients in their study with malnutrition or in other words PEW (13), but they reported more patients with normal nutritional status compared with our study (30.1% versus 10.2%) (13). This difference could be pertinent to the differences in study population or study area in various countries or HD centers. Moreover, it seems that defining PEW according to the criteria by International Society of Renal Nutrition and Metabolism could possibly overestimate the number of malnourished patients compared to SGA or other methods and this needs further investigation to better elucidate the best method of nutritional assessment in HD patients.

In addition, PEW was also determined according to nPCR calculations. Those with measures lower than or equal to 0.8 g/kg/d were considered nutritionally wasted according to the criteria by International Society of Renal Nutrition and Metabolism (13). Based on this assessment, more than 60 percent of the studied HD patients had PEW in the current study and this was not in line with the results achieved by SGA method in our study and they were not correlated. It seems that nPCR overestimated the number of PEW patients. In fact, this result is in line with the results from PEW definition by the criteria by International Society of Renal Nutrition and Metabolism that reported a high percent. This similarity is because of the fact that nPCR is itself a component of the aforementioned criteria. On the other hand, there was a negative correlation between SGA score and nPCR measure that was not statistically significant but has clinical importance. This would confirm the fact that lower protein intake (ie. low nPCR) is associated with poor nutritional status (higher SGA score) and that's why we are not permitted to recommend very low protein diets to HD patients as it could be associated with malnutrition and this can in turn affect outcomes, morbidity, and mortality in this group(17).

On the other hand, according to our analysis, SGA and MUST had the highest specificity and sensitivity which shows their strength in finding the true negative and true positive cases with malnutrition. As an appropriate and acceptable way of assessing malnutrition in HD patients, SGA had a higher precision rate than MUST or nPCR. This shows the superiority of SGA for assessing malnutrition in HD patients. On the other hand, considering the low sensitivity, specificity and precision rate of nPCR, this method could not be an acceptable way of nutrition assessment in HD patients and could be considered a flawed marker of malnutrition.

This study has some limitations. First of all, the patients' laboratory data were used from their medical records and it would be more careful to check it for each patient with the same conditions of sampling. However, it has some strengths from which the most important one is related to that fact that different methods of nutritional assessment were examined at the same time and some of the examined methods were not studied that much (such as MUST).

Conclusion

Based on the results of the present study, it can be summarized that comparing with SGA as a common and acceptable method of nutritional assessment in HD patients, nPCR or the criteria by International Society of Renal Nutrition and Metabolism for PEW seems to overestimate the number of malnourished patients in this group and it seems that nPCR is a flawed marker of malnutrition assessment due to its low sensitivity, specificity, and precision rate. Furthermore, it seems that MUST is significantly associated with SGA in assessing nutritional status, but their classifications in showing different grades of malnutrition could be possibly different. Moreover, both of them (SGA and MUST) had a good precision, sensitivity, and specificity to detect malnutrition in HD patients. As MUST questionnaire was not previously used for assessing malnutrition in HD patients, further investigations are warranted to better explain its accuracy, validity, and reliability in evaluating nutritional status in these patients. Finding the best, easy, and quick method of nutrition assessment in HD patients is of great importance for ensuring adequate nutritional intervention in order to reduce poor prognosis, morbidity, and mortality in these high risk patients.

Abbreviations

HD: hemodialysis; nPCR: normalized protein catabolic ratio; SGA: subjective global assessment; MUST: malnutrition-universal screening tool; Cr: creatinine; BUN: blood urea nitrogen; PEW: protein-energy wasting; BMI: body mass index;

Declarations

Ethics and consent to participate:

The study protocol was reviewed and approved by the ethics committee of Shiraz University of Medical Sciences (Shiraz, Iran). The study process was described to all of the participants and we promised for the confidentiality of the information gathered from them and finally all of the participants signed the written consent for participation.

Consent for publication:

Not applicable.

Authors' contributions

The contribution of all authors to this article in design, data collection, analyzing data and writing of the article is explained below:

Z.S: participated in the study design of the work, data collection and analysis and writing of the manuscript.

A.K: participated in the study design, coordination, data gathering, drafting and critical revision of the paper.

H.M: participated in the study design of the work, data collection and analysis and writing of the manuscript.

M.N: participated in the study design of the work, data collection and analysis and writing of the manuscript.

M.Z: participated in the study design, data analysis and review the paper.

N.H: participated in the study design, data gathering and review the paper.

M.A: participated in the study design, coordination and critical revision of the paper.

All authors read and approved the final manuscript.

The data of the study can be available for the reviewers or researchers.

The authors had no conflict of interest to declare.

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Competing interest: None declared.

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Figures

'Malnutrition Universal Screening Tool'

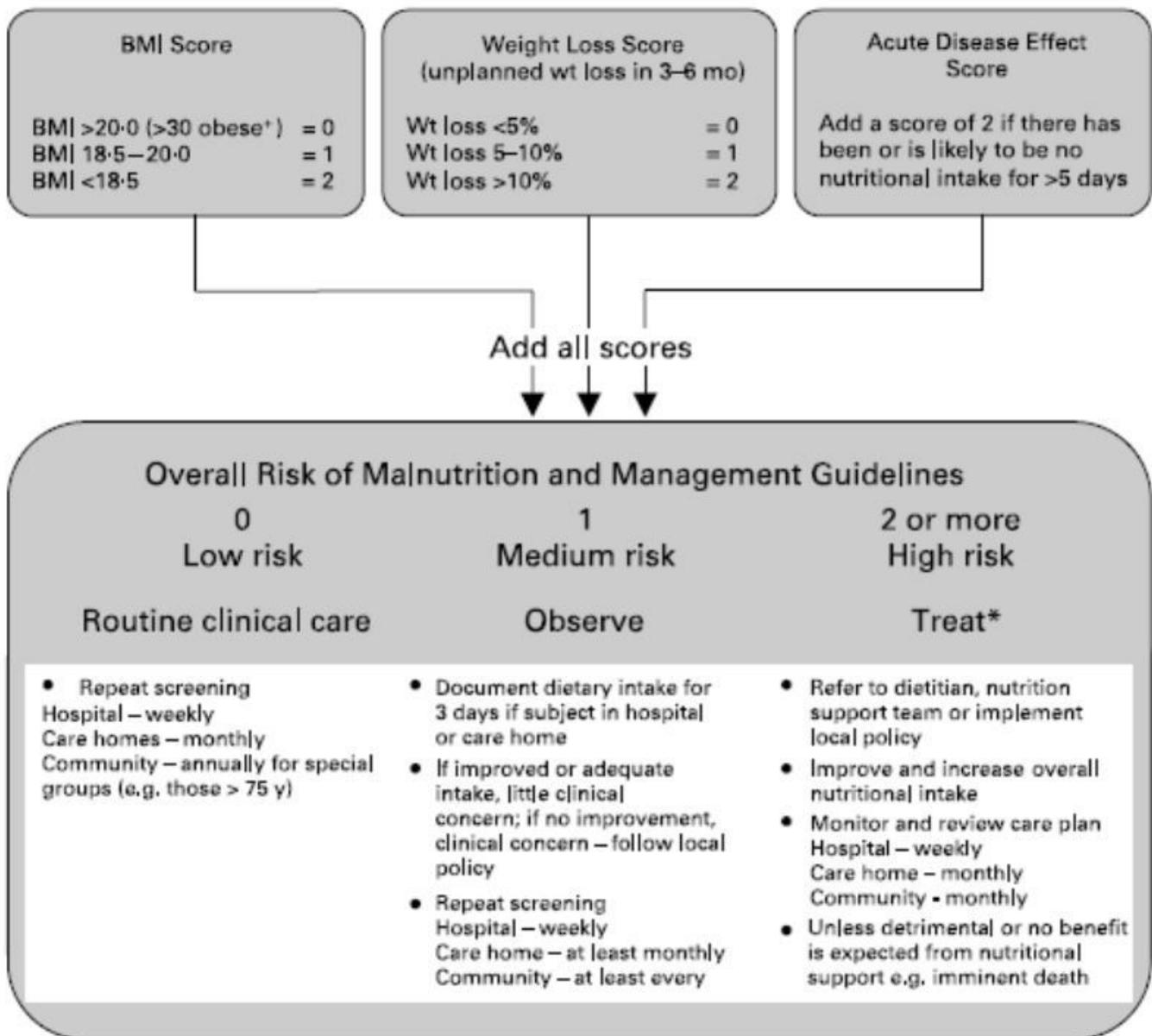


Figure 1

Malnutrition Universal Screening Tool (MUST)

Supplementary Files

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