Original Article

Nutritional Status Assessment of Inpatients with Non Communicable Diseases: Systematic Review Article

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Abstract

Background and Aims: Different diagnostic tools are used in the identification of malnutrition in hospitalized patients. The aim of this article is to review the main diagnostic tools used in the assessment of nutritional status of inpatients with NCDs in the last ten years.
Methods: Data needed for this review were collected through searching PubMed, Sciencedirect and Google Scholar databases, for the period from 2010 to 2020. MeSH keywords included "non-communicable diseases" "nutritional status" "nutritional status assessment" "malnutrition" "inpatients". The data were summarized and were analyzed using Content Analysis.
Result: Out of 374 articles, 10 articles were included in the study. Regarding the contents extracted, data were categorized into 2 topics namely; criteria of diagnosis of malnutrition of NCDs'inpatients and tools of nutritional status assessment of NCDs'inpatients. Three criteria of diagnosis were reviewed: diagnosis of the disease, age and nutritional variables. The main tools of diagnosis are: BBT tool, GLIM criteria, GNRI, MNA, MST and MUST, NRS 2002, SGA and PG-SGA, SNAQ and anthropometric parameters.
Conclusion: this review represent nutritional status assessment tools all combined in one reference that makes it easier for researchers, health professionals and nutritionists to choose the appropriate tool according to their research goals (diagnosis, prediction, evaluation), their samples (adults, elderly),and their available resources.

Keys words: Assessment, malnutrition, non communicable diseases, hospital care.

Introduction

Non-communicable diseases (NCDs) are the end result of long-term exposure to adverse lifestyle and environmental factors. Cardiovascular disease (CVD), diabetes, cancer and chronic respiratory disease are the principle NCDs (Steyn and Damasceno, 2006). NCDs cause tens of millions of deaths each year, many of which are preventable and premature (Nikolic, Stanciole and July, 2011). Most NCDs require repeated interactions with the health system with almost half of total hospital spending (Garg and Evans, 2011; WHO, 2014). Furthermore this high prevalence of hospitalization is also due to comorbidities, infection risks and aging health issues (Unwin *et al.*, 2006; Ogoina and Onyemelukwe, 2009; Nikolic, Stanciole and July, 2011; Banerjee, Nikumb and Thakur, 2013; Palache, Tainijoki-seyer and Collins, 2014; WHO, 2016; Kämpfen *et al*., 2018).

Malnutrition among hospitalized patients is recognized as one of the most common and significant health issues in care settings, it is associated with adverse clinical outcomes, including longer length of stay, increased morbidity and mortality, readmissions, increased hospital costs and decreased life quality (Bauer *et al.*, 2012; Kang *et al.*, 2018; Tran, 2018). Malnutrition is observed in individuals that lack adequate quantities of calories, proteins, or other nutrients for the maintenance of their body functions. It occurs as a result of a complex interrelation between the underlying diseases, the metabolic abnormalities related to the diseases, and reduced availability of nutrients (Hyeda and Costa, 2017). Malnutrition during hospitalization is caused by many factors including impact of treatment, starvation (pre- and post operation, pre-diagnostic), socioeconomic conditions and the ignorance of health care services related to nutrition and hospital food services (Dzieniszewski *et al.*, 2005; Okkels *et al.*, 2016; Vanherle *et al.*, 2018). Malnutrition is common, but although its risks and its subsequent adverse effects on the body it is overlooked by healthcare professionals, that is why the importance of nutrition to overall physical health should be viewed as an important aspect of patient care and be addressed by all healthcare professionals (Donnelly, 2018; Keaver *et al.*, 2018). Different diagnostic tools are used in the identification of malnutrition in hospitalized patients (Tran, 2018). The reliability of nutritional assessment parameters are questioned because of non-nutrition-related factors that may affect the data, therefore, scientists recommend comprehensive nutrition assessment tools (Bauer *et al.*, 2012).

The aim of this review article is to provide a comprehensive reference for nutritionists and health professionals regarding the diagnosis and prognosis of malnutrition by representing the diagnostic criteria of malnutrition and the main tools used in the assessment of nutritional status of inpatients with NCDs in the last ten years.

Materials and methods

In this review article, the required data were retrieved from PubMed, Sciencedirect and Google scholar databases. Searches were conducted with the MeSH search terms “non-communicable diseases” “nutritional status” “nutritional status assessment” “malnutrition” “inpatients”. Articles in English published between 2010 and 2020 evaluating the nutritional status of inpatients with the main four NCDs were included. Clinical studies, clinical trials, research articles, reviews and case reports were eligible to this article. Mendeley desktop 1.19.4 software package was used for organizing, title and abstract reviewing and identifying duplicated articles. The retrieved data were selected and extracted using PRISMA guidelines (Figure 1). Regarding the contents extracted, data were categorized into 2 topics namely; criteria of diagnosis of malnutrition of NCDs’inpatients and tools of nutritional assessment of NCDs’inpatients.

Results and discussion

Out of 374 retrieved publications, 41 ones were excluded from the study for duplication then 314 were excluded because they were non relevant. Therefore, only 10 studies were processed in this review (Figure 1).Out of these ten articles, Four studies were about nutritional assessment of inpatients with cancer (Shaw *et al.*, 2015; De Melo Silva *et al.*, 2017; Contreras-Bolívar *et al.*, 2019; Van *et al.*, 2019), three (Pathirana *et al.*, 2014; Bonilla-Palomas *et al.*, 2016; Sato *et al.*, 2019) were about CVDs’ inpatients, including heart failure (Bonilla-Palomas *et al.*, 2016) and stroke (Sato *et al.*, 2019) ; two studies were about diabetes (Martín *et al.*, 2016; Liu *et al.*, 2017) and one about COPD and asthma (Gaur *et al.*, 2013).The analysis of information through the review leaded to two categories of results as follows:

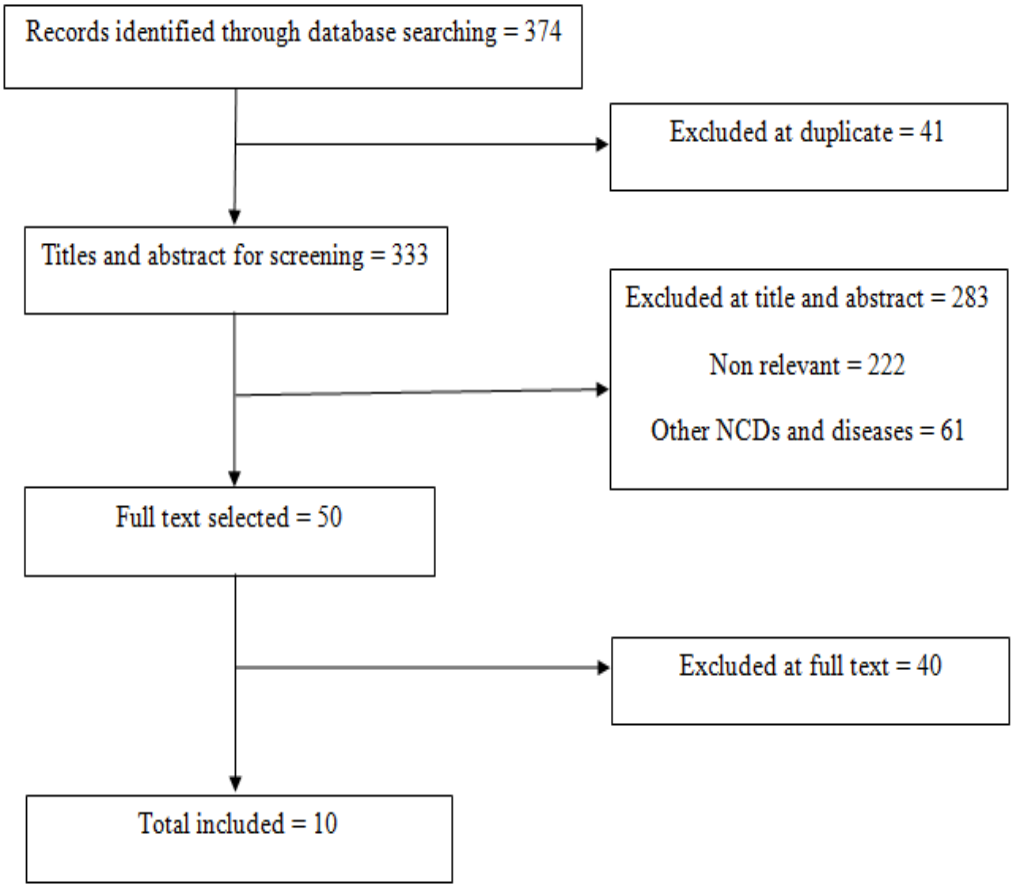

Figure 1: Literature review and retrieval flow diagram

Criteria of nutritional assessment diagnosis of NCDs'inpatients

Diagnosis of the disease

The diagnosis of the NCD is made by different methods and takes in consideration all health status conditions that can be factors of exclusion. The patients are diagnosed by specialists, physicians and geriatricians based on clinical and subclinical symptoms and appropriate machines. This diagnostic could lead to a classification of the disease, the stage of cancer and the type of diabetes (Gaur *et al.*, 2013; Liu *et al.*, 2017; Sato *et al.*, 2019; Van *et al.*, 2019).The second option is to identify the targeted population in the admission units for each disease (Pathirana *et al.*, 2014; Shaw *et al.*, 2015; Bonilla-Palomas *et al.*, 2016; Martín *et al.*, 2016; De Melo Silva *et al.*, 2017; Contreras-Bolívar *et al.*, 2019). The main factors of exclusion are the presence of comorbidities of NCDs (Gaur *et al.*, 2013), the history of or the presence of other diseases that might affect the nutritional status, chronic infections and inflammations (Gaur *et al.*, 2013; Van *et al.*, 2019), pregnant and lactating women, patients with consumptive disorders, mental incapacity and deadly diseases, are excluded (Pathirana *et al.*, 2014; Shaw *et al.*, 2015; Martín *et al.*, 2016; De Melo Silva *et al.*, 2017). For diabetes, newly diagnosed cases at admission are excluded, in order to exclude hyperglycemia due to stress (Martín *et al.*, 2016).

Age

All the studies about the nutritional assessment concern adults of more than 18 years old, some studies focus on older patients (Gaur *et al.*, 2013; Martín *et al.*, 2016; Liu *et al.*, 2017; Sato *et al.*, 2019), but the mean age of all studies is above 50 years old. According to Syed *et al.* (2019) increasing age-adjusted prevalence rates of NCDs are observed with increasing age. An estimated of 15,2 million (38%) of NCDs deaths occurred in people aged between 30 years and 70 years, and 23,6 million (58%) in people aged 70 years and older (Bennett *et al.*, 2018).

Nutritional variables

The diagnostic of malnutrition uses anthropometric parameters, biological markers and dietary monitoring (Aussel and Ziegler, 2014).

Anthropometry

Anthropometry has always been an important and the best tool in the diagnosis, management & prognosis of malnutrition in clinic and in community settings (Phadke *et al.*, 2020). Anthropometric parameters reviewed in this paper are : current weight (kg), height (m2), Body Mass Index "BMI" (Kg/m2), habitual weight (kg) (De Melo Silva *et al.*, 2017), weight loss percentage and previous BMI (De Melo Silva *et al.*, 2017; Contreras-Bolívar *et al.*, 2019). Percentage of ideal BW (PIBW), fat mass (FM) and midthigh cross-sectional (Gaur *et al.*, 2013), fat-free mass index (FFMI) (Gaur *et al.*, 2013; Contreras-Bolívar *et al.*, 2019), hand grip strength, mid-arm circumference (MAC), and arm muscular circumference (AMC) (Liu *et al.*, 2017; Contreras-Bolívar *et al.*, 2019) and tricipital skin fold thickness (Bonilla-Palomas *et al.*, 2016; Liu *et al.*, 2017).

Biological markers

Six out of the ten selected studies use biological markers to detect malnutrition (Pathirana *et al.*, 2014; Bonilla-Palomas *et al.*, 2016; Martín *et al.*, 2016; Liu *et al.*, 2017; Contreras-Bolívar *et al.*, 2019; Sato *et al.*, 2019).Nutritional biomarkers are indicators of dietary exposure and indicate past dietary intakes (Pande *et al.*, 2018). Physicians used serum proteins such as albumin and prealbumin (i.e. transthyretin) to determine patients' nutritional status (figure 2).

Other markers that have been studied include retinol-binding protein (RBP), transferrin, total cholesterol and indicators of inflammation such as C-reactive protein (CRP) and total lymphocyte count (TLC) (Bharadwaj *et al.*, 2016).

In malnourished patients, there is an associated disease-related inflammation, the appreciation that inflammation plays a role in the pathophysiology of malnutrition is often lacking, and clinicians assume that weight loss is the most important criterion for a malnourished state, that's why laboratory markers are not reliable by themselves, but used as a complement to a thorough physical examination (Bharadwaj *et al.*, 2016; Keller, 2019). An exemplary nutritional marker should be unaffected by presence of other diseases, easily and accurately tested with easily available equipment in the hospitals, and affordable for the patients (Pande *et al.*, 2018).

Dietary monitoring

Nine out of the ten reviewed articles use dietary monitoring to assess the nutritional status of the inpatients, separately (Bonilla-Palomas *et al.*, 2016), or included in a nutritional assessment tool.A thorough dietary history is essential and it includes assessment of current food and fluid intake, previous intake, and any recent changes, it provides information about eating habits, potential nutrition deficiencies, and reasons for sub-optimal intake (Davies, 2005; Alberda, Graf and McCargar, 2006).

In addition, the assessment aims to detect food aversions, eating patterns, dietary restrictions including ethnic and religious influences, intolerances and allergies and problems with feeding (appetite and taste changes), gastrointestinal symptoms, chewing and swallowing ability and requirements for assistance with feeding and/or cooking (Davies, 2005; Alberda, Graf and McCargar, 2006). In cases where deficits are detected, some form of supplementation may be advised (Davies, 2005).

Tools of nutritional assessment

Anthropometric parameters

Gaur *et al.*, 2013 used only anthropometric parameters to evaluate the nutritional status of COPD and asthma inpatients. Anthropometry is a simple tool for assessing nutritional status in individuals and communities and offers the advantages of objectivity and relatively 'low technology'(Duggan, 2010). Various anthropometric measurements help to assess malnutrition. They are as under: age dependant anthropometric measurements and age independent (or partially dependent) anthropometric measurements (table 1) (Phadke *et al.*, 2020).

Anthropometry is an inexpensive, non-invasive and highly sensitive method for nutritional assessment; however there are some difficulties associated with anthropometric measurements, like technical error of measurement (TEM) and the influence of other factors like cormic index, oedema, cut-off point etc. (Krishan and Kanchan, 2016; Bhattacharya *et al.*, 2019)

.**Table 1**: Anthropometric measurements to assess malnutrition

Age dependant anthropometric measurements	Age Independent anthropometric measurements
Weight (Wt) Height (Ht) Occipitofrontal circumference (Head circumference) Chest circumference Wt for age, Ht for age	Mid upper arm circumference (MUAC) Body mass index (BMI) Skin-fold thickness-triceps, sub-scapular, biceps, suprailiac etc. Indices – Wt. for height, Wt for length Various ratios

Table 2: Interpretation of Nutritional Risk Index (NRI) and Geriatric Nutritional Risk Index (GNRI)

	NRI	GNRI
Absence of malnutrition	> 97.5	> 98
Low malnutrition		92 to ≤ 98
Moderate malnutrition	83.5-97.5	82 to < 92
Severe malnutrition:	< 83.5	<82

Table 3: Components of the Subjective Global Assessment (SGA) (Makhija and Baker, 2008)

History	**Physical exam**
Weight change fat • Overall loss in past 6 months • Change is in the past 2 weeks Dietary intake change • Increase, decrease, or no change Gastrointestinal symptoms for >2 weeks • None, nausea, vomiting, diarrhea, anorexia Functional capacity • No dysfunction vs. dysfunction Disease and its relation to nutrition status • Primary diagnosis • Metabolic demand	Loss of subcutaneous Muscle wasting Ankle edema Sacral edema Ascites

Table 4: Different forms of Mini Nutritional Assessment tool

MNA form	Date of development	Characteristics
The full version (F-MNA)	1994	Includes 18 items evaluating anthropometric, general dietary and self-assessment domains; Designed to be completed in 10-15 minutes; Classifies the individuals as “malnourished”, “at risk of malnutrition” and “well-nourished”.
MNA short form (MNA-SF)	2001	A reduced version of the F-MNA; Evaluates 6 items from the F-MNA (including body mass index (BMI)) and classifies subjects in two categories: “well-nourished” and “possibility of malnutrition”.
MNA modified form (m- MNA)	2008	Including 7 items of the F-MNA (weight loss, mobility, BMI, number of full meals, fluid consumption, mode of feeding, health status); With new cutoffs (12.5-15 well-nourished, 9-12 at risk of malnutrition,<9 malnourished).

The new version (MNA-SF-BMI)	2009	Includes the same six items as the original MNA-SF but classifies individuals in three categories: “malnourished”, “at risk of malnutrition” and “well-nourished”.
The new version (MNA-SF-CC)	2009	A variant of the MNA-SF-BMI, which replaces the question related to BMI with a question about calf circumference (modifying its scores: 0 or 3 instead 0 or 1) Offers the same cut-off points and total scores as the MNA-SF-BMI and provides an easier tool for patients whose BMI is not available.
MNA reduced form (r-MNA)	2015	Two cut-off points were established to allow the classification of patients in three categories depending on the score obtained: malnourished, at risk or well-nourished.

Table 5: Malnutrition Screening Tool (MST)

Question	Score
Have you lost weight recently without trying?	
No	0
Ensure	2
Yes	See below
If yes, how much weight (Kg) have you lost?	
1-5	1
6-10	2
11-15	3
>15	4
Ensure	2
Have you been eating poorly because of a decreased appetite?	
No	0
Yes	1
Total score	Maximum 7
Score of >2 categorizes patient as malnourished	

Table 6: The Royal Marsden Nutrition Screening Tool (RMNST)

Question	If answer to the question is yes, then score
Has the patient experienced unintentional weight loss in the last 3 months?	
(> 7 in men or > 5,5 in women)	10
If not, unintentional weight loss less than the above	5
Does the patient look underweight? 5	
Has the patient had a reduced food intake (less than 50% of meals) in the last 5 days (this may be due to to mucositis, dysphagia, nausea, bowel obstruction, vomiting)?	5
Is the patient experiencing symptoms that are affecting food intake, e.g. mucositis, nausea, vomiting, diarrhoea and constipation?	3
Total score	Maximum 23
Copyright The Royal Marsden NHS Foundation Trust Score 0–4, well-nourished, score 5–9, moderately malnourished, score >10, severely malnourished	

Table 7 : The Short Nutritional Assessment Questionnaire (SNAQ) (Kruizenga *et al.*, 2005; Dionyssiotis, 2014)

Question	Score
Did you lose weight unintentionally? • More than 6 kg in the last 6 months • more than 3 kg in the last month	 3 points 2 points
Did you experience a decreased appetite over the last month?	1 point
Did you use supplemental drinks or tube feeding over the last month?	1 point
< 2 points : well-nourished 2 points : moderately malnourished ≥ 3 points: severely malnourished	

Table 8: Thresholds for severity grading of malnutrition into Stage 1 and Stage 2 malnutrition.

	Phenotypic criteria		
	Weight loss (%)	Body Mass Index (Kg/m^2)	Reduced muscle mass
Stage 1/Moderate Malnutrition (Requires 1 phenotypic criterion that meets this grade)	5-10% within the last 6mo. Or 10-20% beyond 6mo.	< 20 if < 70 yr. < 22 if ≥ 70 yr	Mild to moderate deficit (per validated assessment methods)
Stage 2/ Severe Malnutrition (Requires 1 phenotypic criterion that meets this grade)	> 10% within the past 6 mo. Or > 20% beyond 6mo.	< 18.5 if < 70 yr. < 20 if 70≥ yr	Severe deficit (per validated assessment methods)

Nutritional Risk Index (NRI) and Geriatric Nutritional Risk Index (GNRI)

Sato *et al.*, 2019 uses the GNRI which is an adaptation of the NRI (Bouillanne *et al.*, 2005) to assess the nutritional status of inpatients. The NRI, was proposed by (Buzby *et al.*, 1988) for evaluating nutritional status of preoperative patients on total parenteral nutrition (Sagou *et al.*, 2019). It combines 2 nutritional indicators (albumin and weight loss). By extension, it is used as an index of malnutrition in hospitalized adults (Bouillanne *et al.*, 2005).

NRI = 1.519 × alb + 0.417 × (current weight / weight usual) × 100

The usual weight is often impossible to obtain in elderly patients; Bouillanne *et al.*, 2005 replaced it by ideal body weight in the NRI formula and named the resulting index the Geriatric Nutritional Risk Index (GNRI). GNRI is based on a calculation that utilizes three variables: serum albumin (Alb), height, and body weight, according to this formula:

GNRI = (1,489 x alb [g/L]) + (41,7x actual body weight [kg] / ideal body weight [kg]

The results of the NRI and GNRI assessment were categorized as follows (table 2) (Prasad *et al.*, 2016; Sato *et al.*, 2019).

Subjective Global Assessment (SGA) and Patient-Generated Subjective Global Assessment (PG-SGA)

Four reviewed studies used the SGA or the PG-SGA to assess the nutritional status of inpatients (Pathirana *et al.*, 2014; Shaw *et al.*, 2015; De Melo Silva et al., 2017; Van *et al.*, 2019). Subjective global assessment (SGA) is a validated method of nutritional assessment and physical examination (table 3) (Bauer, Capra and Ferguson, 2002; Makhija and Baker, 2008). It classifies nutrition status as well-nourished (A), mild to moderately malnourished (B), or severely malnourished (C). A patient is rated as SGA class B if there was at least 5% weight loss without any recent stabilization or regain, reduction in dietary intake, and mild loss of subcutaneous tissue. A patient is ranked as SGA class C if he or she had severe loss of subcutaneous tissue, muscle wasting, and edema (Campbell *et al.*, 2007; Makhija and Baker, 2008).

The PG-SGA was adapted from the SGA and has been considered as the standard method of

nutritional assessment for patients with cancer (Bauer, Capra and Ferguson, 2002; Santos *et al.*, 2017). It is composed of questions about changes in weight and dietary intake, gastrointestinal symptoms, and functional capacity, answered by the patient. It includes a form containing data on increased nutritional needs due to the disease, metabolic demand, and physical examination (Appendix 1). The scored PG-SGA incorporates a numerical score and a global rating in which higher scores are indicative of greater nutritional risk (Campbell *et al.*, 2007; Santos *et al.*, 2017). For each component of the scored PG-SGA, points (0 – 4) are awarded depending on the impact of the symptom on nutritional status. the sum of the scores obtained in each domain is classified according to the following SGA classification: SGA A (well-nourished), SGA B (moderately malnourished) and SGA C (severely malnourished) (Campbell *et al.*, 2007; Santos *et al.*, 2017). The scored PG-SGA, unlike SGA, which is categorical, is a continuous measure (Bauer, Capra and Ferguson, 2002).

Mini Nutritional Assessment (MNA)

The MNA (Appendix 2) consists of 18 questions grouped into 4 parts: anthropometry (BMI, weight loss, mid-upper arm, and calf circumferences), clinical status (medications, mobility, pressure sores and skin ulcers, lifestyle, psychological stress or neuropsychological problems), dietary assessment (autonomy on feeding, quality and number of meals, fluid intake), and self-perception about health and nutrition (Donini *et al.*, 2016)The maximum MNA score is 30 points. a score <17 indicated malnutrition, 17–23.5 points indicated a risk of malnutrition and a score ≥ 24 points indicated good nutritional status (Liu *et al.*, 2017). There are many forms of MNA (table 4) (Hengstermann *et al.*, 2008; Kaiser *et al.*, 2009; Martín *et al.*, 2016).

Malnutrition Screening Tool (MST) and Malnutrition Universal Screening Tool (MUST)

Pathirana *et al.*, 2014 and Shaw *et al.*, 2015 used the MUST and MST tools to assess the nutritional status of cardiac and cancer inpatients. The MST was designed by Ferguson *et al.*, 1999, it is a simple, three-questions tool assessing recent unintentional weight and appetite loss (table 5) (Raja *et al.*, 2008; Pathirana *et al.*, 2014). The MST has good sensitivity and specificity when applied to the general hospitalized population (Shaw *et al.*, 2015).

The MUST (Appendix 3) categorizes patients for their risk of malnutrition; it is easy, rapid, reproducible, and consistent. MUST can be used in patients in whom height and weight are not obtainable, as a range of alternative measures and subjective criteria are provided (BAPEN, 2003). It assess body mass index, unplanned weight loss in past 3–6 months and the presence or absence of acute illness or lack of nutritional intake >5 days (Pathirana *et al.*, 2014).It scores risk from low (score of 0) to high (a score of 2 or more). It requires a record of anthropometry, followed by a documented management plan for all patients based on the scores obtained. Both tools (MST and MUST)are expected to prompt dietetic referrals for further assessment (Raja *et al.*, 2008).

The Royal Marsden Nutrition Screening Tool (RMNST)

The RMNST was developed through the professional consensus by the Department of Nutrition and Dietetics of the Royal Marsden NHS Foundation Trust for inpatient use (table 6). It is designed to be used on admission and weekly thereafter, in order to detect changes in risk of malnutrition. The tool incorporates important parameters in nutritional screening and symptoms that affect food intake in cancer patients. The RMNST was designed to categorize patients who had lost 10% of their body weight as severely malnourished and those with a smaller weight loss in the moderately malnourished category. Cumulative scoring based on reduced food intake and symptoms, even in the absence of weight loss, would categorize the patient in the moderately malnourished group or 'at risk'(Shaw *et al.*, 2015).

The Nutritional Risk Screening 2002 (NRS 2002)

Pathirana *et al.*, 2014 used the NRS 2002 (Appendix 4) (Kondrup *et al.*, 2003) to assess the nutritional status of cardiac inpatients.NRS 2002 was developed to identify patients at risk to start nutrition intervention before signs of malnutrition are evident. The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends NRS-2002 for hospital use and screening purposes within 48 h of admission. NRS includes assessment of the patient's nutritional status (low, moderate or severe: based on weight loss, BMI and general condition or food intake and disease severity (stress metabolism due to the degree of

disease), with an adjustment of one extra point for age of ≥70. The final scoring of NRS-2002 ranges from 0 to 7, and a score of ≥3 denotes nutritional risk and is associated with higher risk for adverse outcomes (Orell-Kotikangas *et al.*, 2015; Hersberger *et al.*, 2019).

Simplified Nutritional Appetite Questionnaire (SNAQ)

The SNAQ (table 8) was developed and validated by Kruizenga *et al.*, 2005. It is a valid and reproducible instrument to detect and treat malnourished hospital patients in an early stage of hospitalization without the need to calculate percentage weight loss or BMI. SNAQ was originally developed for hospital inpatients, in whom unintentional weight loss due to acute illness is more prevalent than a low BMI. As the SNAQ is a quick-and-easy screening tool in which BMI is not included, the tool is likely to miss patients with a low BMI (Leistra *et al.*, 2013).

Bach Mai Boston tool (BBT)

The BBT is a new assessment tool developed by Vietnam Bach Mai Hospital, in collaboration with Boston University in the United States, to shorten the time taken by health professionals for nutritional screening. It is a questionnaire used to collect patients' information. Descriptive information included age, gender, cancer diagnosis, weight and height. The BBT have 3 questions about oral intake, BMI, and weight loss in the last 3 months. There are 3 levels of the BBT score: level A (no risk), level B (low/mild risk), or level C (high risk) (figure 3) (Manders *et al.*, 2015; Van *et al.*, 2019). The BBT is validated for use among oncology patients, and it has good sensitivity and specificity. It enables malnourished oncology patients to be identified and triaged for nutritional support (Van *et al.*, 2019).

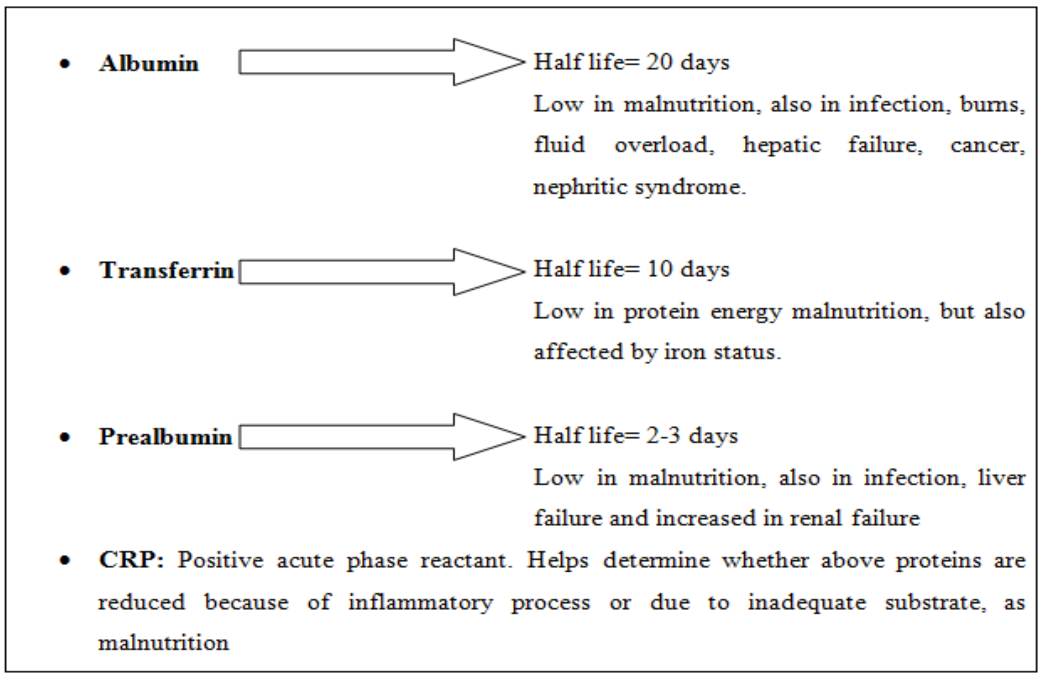

Figure 2: Laboratory markers (Bharadwaj *et al.*, 2016)

Global Leadership Initiative on Malnutrition criteria: GLIM criteria

The GLIM criteria for the diagnosis of malnutrition were published with the aim to build a global consensus around core diagnostic criteria for malnutrition in adults in clinical settings (Contreras-Bolívar *et al.*, 2019).

Unintentional weight loss, reduced BMI, and reduced muscle mass are phenotypic criteria, and reduced food intake/ assimilation and disease burden/inflammation are etiologic criteria. For the diagnosis of malnutrition, GLIM recommends that the combination of at least one phenotypic criterion and one etiologic criterion is required (figure 4) (Cederholm *et al.*, 2019).

While only the phenotypic criteria are proposed for the severity grading that follows, the inclusion of the etiologic criteria for malnutrition diagnosis is deemed a priority to guide appropriate intervention and anticipated outcomes (table 8) (Cederholm *et al.*, 2019).

Parameters	Criteria	A	B	C
Oral intake	Normal		■	■
	Intake ≤ 50% compared to normal	■		■
	Cannot eat	■	■	
BMI	> 18,5		■	■
	16-18,5	■		■
	≤ 16	■	■	
Recent weight loss	Loss ≤ 5%		■	■
	Loss > 5% - 10%	■		■
	Loss 10%	■	■	

No risk: □	Low/mild risk: □	High risk: □
3A	2B+1A	2B+1C
2A+1B	3B	2C+1B
	2A+1C	3C
	1A+1B+1C	

Figure 3: the brief nutrition screening too “Bach Mai Boston tool” (Manders *et al.*, 2015)

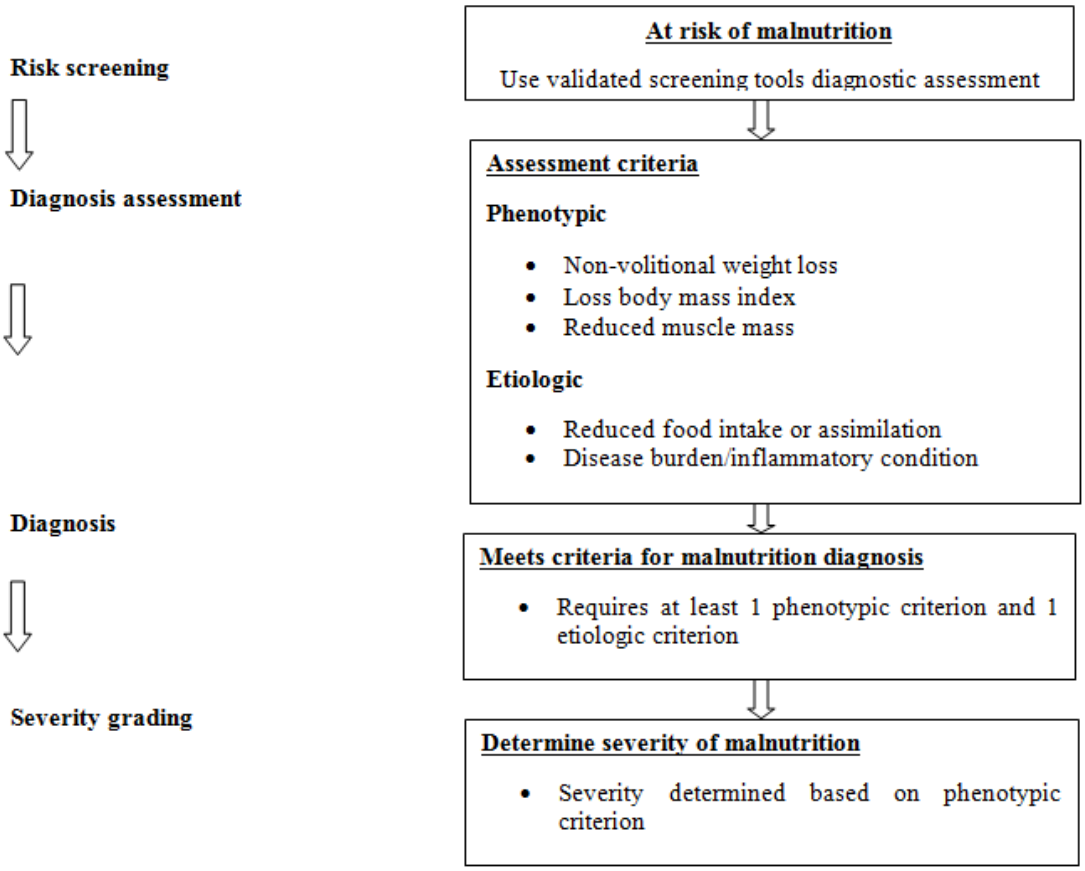

Figure 4: GLIM diagnostic scheme for screening, assessment, diagnosis and grading of malnutrition

Conclusion

The aim of this review is to represent the nutritional status assessment variables of noncommunicable diseases' patients, through research already conducted in the last ten years. This article represent all the tools of the nutritional status assessment all combined in one reference that makes it easier for researchers in the field of nutrition as well as professionals in the health sector and nutritionists to choose the appropriate tool for them according to their research goals (diagnosis, prediction, evaluation), their research samples (adults, elderly), available resources including time, staff and health devices. For example, anthropometry is one of the cheapest means; MNA provides accurate results for the elderly, while BBT and GLIM criteria are preparing for assessing the nutritional status of cancer patients. Also, tools free from biomarkers may be preferred for underfunded health centers.

This review provides the initial choice of the assessment tool or tools (in the case of a comparative study), after which it is the responsibility of the researcher or health professionals to expand to understand the evaluation elements and apply them effectively.

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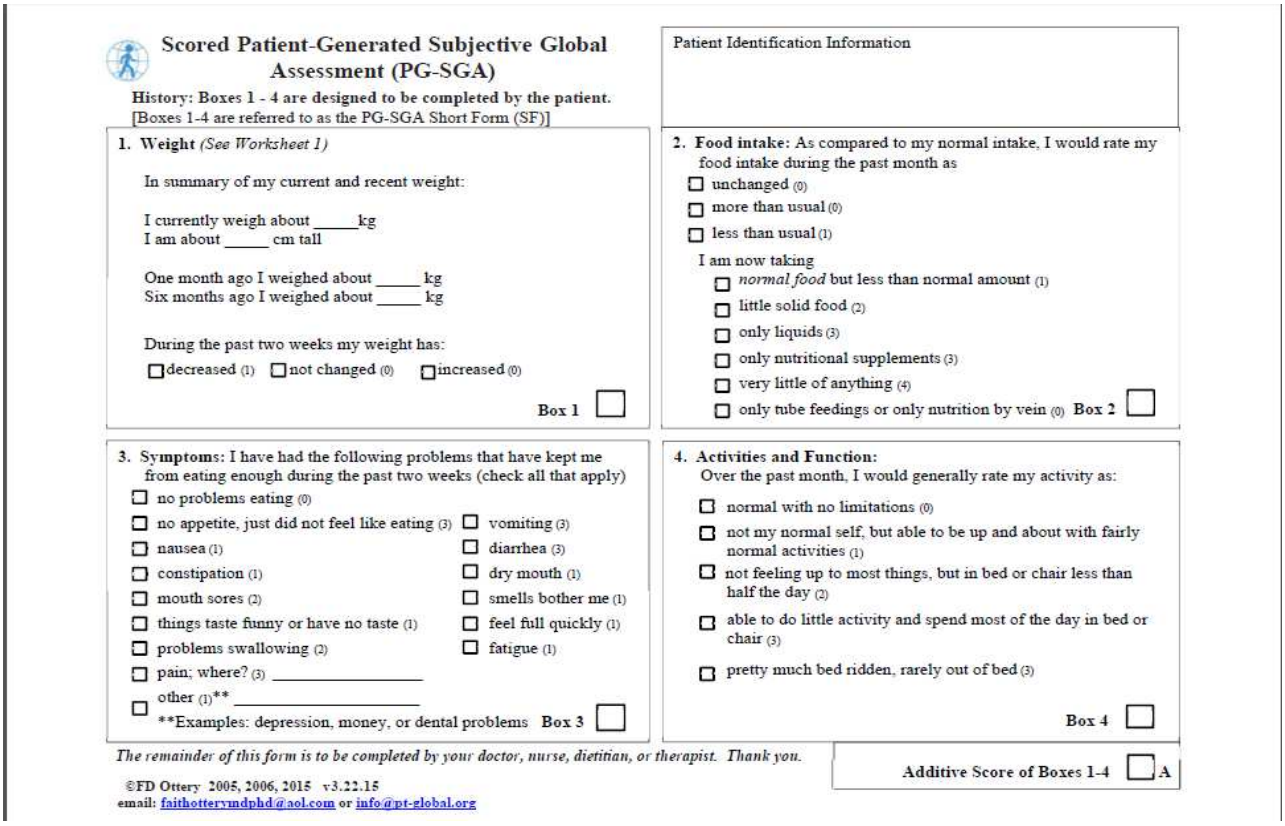
Appendix 1: Patient-Generated Subjective Global Assessment (PG-SGA)



Scored Patient-Generated Subjective Global Assessment (PG-SGA)

History: Boxes 1 - 4 are designed to be completed by the patient.
[Boxes 1-4 are referred to as the PG-SGA Short Form (SF)]

Patient Identification Information

1. Weight *(See Worksheet 1)*

In summary of my current and recent weight:

I currently weigh about _____kg
I am about _____ cm tall

One month ago I weighed about _____ kg
Six months ago I weighed about _____ kg

During the past two weeks my weight has:
☐ decreased (1) ☐ not changed (0) ☐ increased (0)

Box 1 ☐

2. Food intake: As compared to my normal intake, I would rate my food intake during the past month as
☐ unchanged (0)
☐ more than usual (0)
☐ less than usual (1)

I am now taking
☐ *normal food* but less than normal amount (1)
☐ little solid food (2)
☐ only liquids (3)
☐ only nutritional supplements (3)
☐ very little of anything (4)
☐ only tube feedings or only nutrition by vein (0) **Box 2** ☐

3. Symptoms: I have had the following problems that have kept me from eating enough during the past two weeks (check all that apply)
☐ no problems eating (0)
☐ no appetite, just did not feel like eating (3)
☐ nausea (1)
☐ constipation (1)
☐ mouth sores (2)
☐ things taste funny or have no taste (1)
☐ problems swallowing (2)
☐ pain; where? (3) _____
☐ other (1)** _____
☐ vomiting (3)
☐ diarrhea (3)
☐ dry mouth (1)
☐ smells bother me (1)
☐ feel full quickly (1)
☐ fatigue (1)
Examples: depression, money, or dental problems **Box 3 ☐

4. Activities and Function:
Over the past month, I would generally rate my activity as:
☐ normal with no limitations (0)
☐ not my normal self, but able to be up and about with fairly normal activities (1)
☐ not feeling up to most things, but in bed or chair less than half the day (2)
☐ able to do little activity and spend most of the day in bed or chair (3)
☐ pretty much bed ridden, rarely out of bed (3)

Box 4 ☐

The remainder of this form is to be completed by your doctor, nurse, dietitian, or therapist. Thank you.

Additive Score of Boxes 1-4 ☐ **A**

email: faithotteryndphd@aol.com or info@pt-global.org

Appendix 2: Mini Nutritional Assessment tool (MNA)

Mini Nutritional Assessment

MNA®

Nestlé Nutrition Institute

Last name: First name:

Sex: Age: Weight, kg: Height, cm: Date:

Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months?
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F1 Body Mass Index (BMI) (weight in kg) / (height in m)^2 ☐
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

IF BMI IS NOT AVAILABLE, REPLACE QUESTION F1 WITH QUESTION F2.
DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

F2 Calf circumference (CC) in cm
0 = CC less than 31
3 = CC 31 or greater ☐

Screening score ☐☐
(max. 14 points)

12-14 points: ☐ Normal nutritional status
8-11 points: ☐ At risk of malnutrition
0-7 points: ☐ Malnourished

Save Print Reset

Ref. Vellas B, Villars H, Abellan G, et al. *Overview of the MNA® - Its History and Challenges*. J Nutr Health Aging 2006;10:456-465.
Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. *Screening for Undernutrition in Geriatric Practice: Developing the Short-Form Mini Nutritional Assessment (MNA-SF)*. J. Geront 2001;56A: M366-377.
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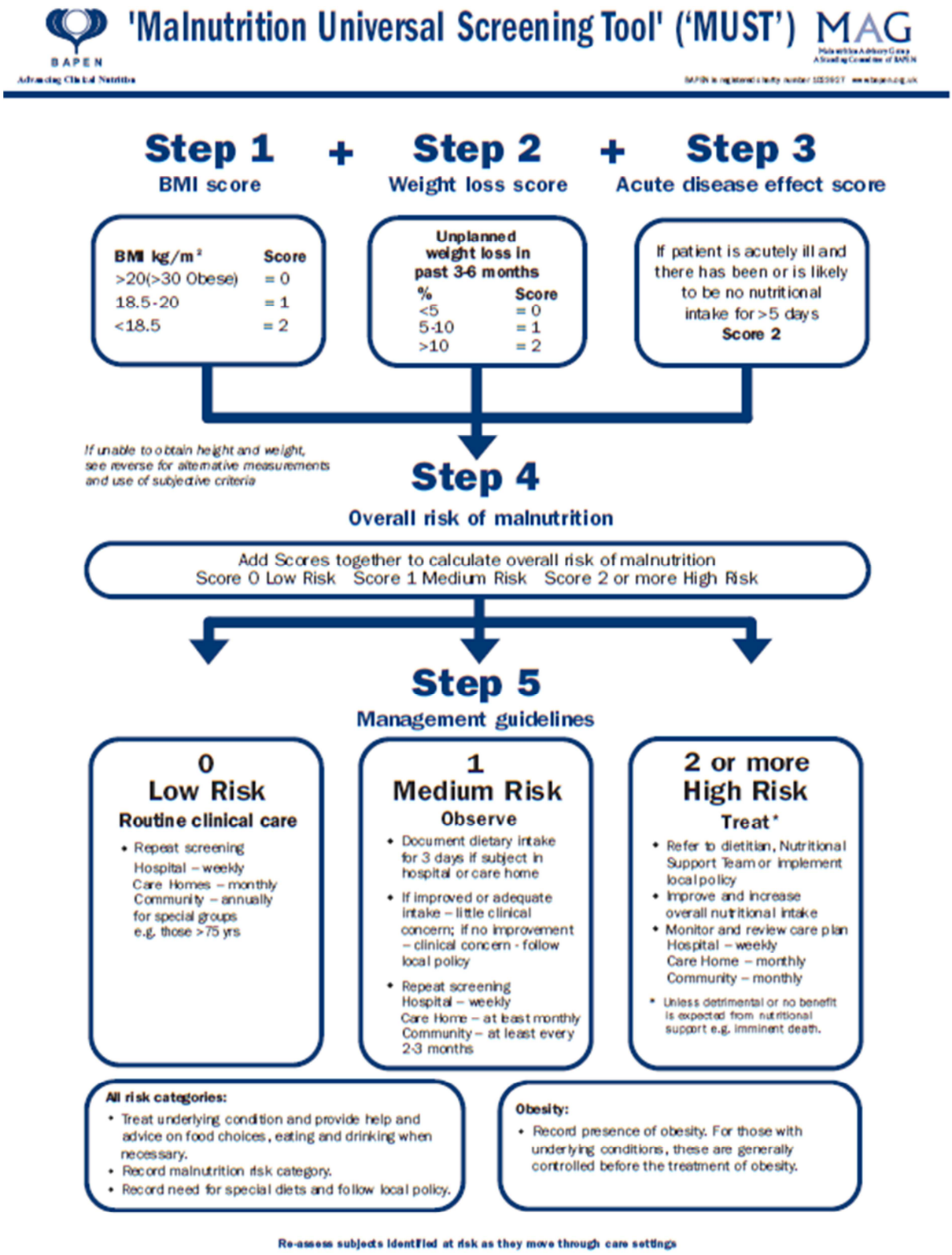
For more information: www.mna-elderly.com

Appendix 3: Malnutrition Universal Screening Tool (MUST)



Appendix 4: Nutritional Risk Screening 2002

Impaired nutritional status		Severity of disease (≈ stress metabolism)	
Absent Score 0	Normal nutritional status	Absent Score 0	Normal nutritional requirements
Mild Score 1	Wt loss >5% in 3 months Or Food intake below 50–75% of normal requirement in preceding week	Mild Score 1	Hip fracture Chronic patients, in particular with acute complications: cirrhosis (11), COPD (12) *Chronic hemodialysis, diabetes, oncology*
Moderate Score 2	Wt loss >5% in 2 months Or BMI 18.5 – 20.5 + impaired general condition Or Food intake 25–50% of normal requirement in preceding week	Moderate Score 2	Major abdominal surgery (13–15). Stroke (16) *Severe pneumonia, hematologic malignancy*
Severe Score 3	Wt loss >5% in 1 month (≈ >15% in 3 months (17)) Or BMI <18.5 + impaired general condition (17) Or Food intake 0–25% of normal requirement in preceding week in preceding week.	Severe Score 3	Head injury (18, 19) Bone marrow transplantation (20) *Intensive care patients (APACHE 10*

+

Score:

Total score:

Calculate the total score:

1. Find score (0–3) for Impaired nutritional status (only one: choose the variable with highest score) and Severity of disease (≈ stress metabolism, i.e. increase in nutritional requirements).
2. Add the two scores (→ total score)
3. If age ≥70 years: add 1 to the total score to correct for frailty of elderly
4. If age-corrected total ≥3: start nutritional support