Screening and Assessment of Malnutrition

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2.1 Introduction

Forty years ago, there were preliminary reports pointing out that malnutrition is not only seen in persons living in poor socioeconomic conditions, but it can also be observed in patients admitted to hospitals or living in the community associated to an underlying disease [1]. Many disorders can cause a deterioration of nutritional status. Neurological diseases can be associated with malnutrition due to decreased appetite and intake, frequent occurrence of dysphagia, and varying degree of hypermetabolism [2].

Although common sense would predict that it is not difficult to characterize malnutrition, it is well known that it is not easy to define it [3]. There is a need of a gold standard that allows clinicians and scientists to achieve a consensus definition of malnutrition. A few years ago, a group of experts in clinical nutrition were invited to answer a questionnaire aimed at identifying the main features of malnutrition. The deficiencies of energy or protein and the decrease in fat-free mass were most often cited to be particularly important in defining malnutrition. From the perspective of elements important in delineating malnutrition, involuntary weight loss, body mass index (BMI), and no nutritional intake were also mentioned. However, opinions on cutoff points regarding these elements differed strongly among experts [4].

A few years later, an international consensus committee established a classification of malnutrition syndromes [5]:

– Chronic starvation without inflammation (e.g., anorexia nervosa or major depression with lack of interest in eating)

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– Chronic disease-associated malnutrition, when inflammation is chronic and of mild to moderate degree (e.g., organ failure, pancreatic cancer, rheumatoid arthritis, or sarcopenic obesity)
– Acute disease or injury-associated malnutrition, when inflammation is acute and of severe degree (e.g., major infection, burns, trauma, or closed head injury)

These syndromes are dynamic, in the sense that a patient may change among them and starvation may overlap with acute to chronic inflammatory conditions. Acute conditions may also develop in patients with starvation or chronic disease-related malnutrition. These patients with mixed syndromes have even more reason to need close nutritional attention.

Clinical outcomes such as infectious complications, survival, and rate of recovery from illness are influenced by nutritional status. They can be used as hard measures of nutritional interventions. However, they depend on many physiologic mechanisms and treatments of the underlying disease. Despite its importance from different perspectives, in many diseases, it is difficult to show an improvement in these clinical outcomes with nutritional therapy because its effect is diluted by many other factors. On the other hand, an optimal nutritional status has been related to the ability of maintaining or attaining a body composition and physiologic function that are optimal for the health and long-term survival of the individual. Nutritional intake is one of the factors necessary to accomplish these goals, and, therefore, nutritional assessment will evaluate if any given nutritional intake will fulfill these objectives in a particular individual. However, nutritional status and nutrient intake also depend on other factors such as the presence or absence of disease, physical activity, environment, drug therapy, hormone regulation, central and peripheral nervous system influence, and, especially in disease-related malnutrition, the degree of inflammation [6].

The changes and influences of these factors on nutritional status may be difficult to measure in an objective way. To facilitate the assessment of nutrition, surrogate markers are used. However, it is not possible to establish a perfect direct relationship between a determined marker and nutritional status. The sensitivity, specificity, and validity of each surrogate marker are quite variable per se and in each individual. The underlying disease can influence many surrogate markers. Weight is a useful marker of nutritional status, but edema secondary to heart or renal failure can modify it. In consequence, we cannot be naive and identify an alteration, high or low, of a proposed marker with malnutrition of different degree. In general, the validity of a particular variable as a nutritional marker may vary intensely depending on the clinical situation. The lack of specificity forces the clinician to consider this alteration in the context of the clinical status of the patient [7]. For example, a low albumin concentration does not automatically mean malnutrition or insufficient nutrition intake. It may be due to decrease in hepatic synthesis or catabolism, body losses through diarrhea or urine, and, very significantly, extracellular volume expansion secondary to systemic inflammatory response.

After stressing the difficulties and limitations of nutritional evaluation, we will move forward to analyze the process by which we can estimate the nutritional status of patients. This process has different steps: screening, assessment, nutritional planning, monitoring, registration along with diagnostic coding, and, finally, audit of the whole process [8].

2.2 Nutritional Screening

Nutritional screening identifies patients who are at nutritional risk and will benefit from further nutritional assessment and intervention. Severe malnutrition is clinically obvious, but there is more uncertainty about recognizing lesser degrees of malnutrition. Therefore, in the absence of universally accepted criteria for identifying malnutrition with high sensitivity and specificity, the concept of risk was introduced. Risk is a measure of likelihood that malnutrition is present or likely to develop. In many texts and in usual clinical practice, the terms malnutrition and nutritional risk are often used interchangeably. This may add some confusion in the field of nutritional evaluation.

Numerous screening tools have been developed to identify patients at risk of malnutrition [9]. Any particular tool has to be simple to administer, asking easily answered questions, useful in a particular clinical setting or appropriate across a broad range of conditions and with an acceptable validity. Experts of the European Society for Clinical Nutrition and Metabolism (ESPEN) stated that any nutritional screening tool has to be evidence based and validated. It should include at least three elements:

- Current BMI
- Involuntary recent weight loss
- Information of recent food intake

Figure 2.1 shows the historical development of the most important screening tools that we now will briefly describe.

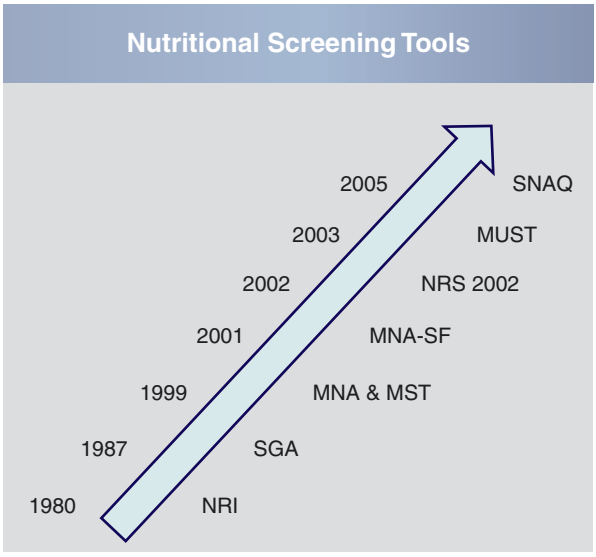

Fig. 2.1 Historical development of nutritional screening tools. Acronyms are described within the text

1. *Nutritional risk index* (*NRI*) is a combination of weight loss percentage and serum albumin concentration [10]. It was used as an inclusion criterion in the Veteran Administration Total Parenteral Nutrition clinical trial to identify patients who were malnourished.

   NRI is calculated according to the formula:

$$\left[1.519 \times \text{serum albumin}\left(\text{g} / \text{L}\right)\right] + \left[0.417 \times \left(\text{present weight} / \text{usual weight} \times 100\right)\right].$$

   NRI > 100 indicates no., 97.5–100 indicates mild, 83.5 ≤ 97.5 indicates moderate, and <83.5 indicates severe malnourishment.

2. *Subjective global assessment* (*SGA*) (Table 2.1) [11], described in 1982, aimed particularly for patients with medical or surgical gastrointestinal diseases. There are five questions focusing on history of unintentional weight loss over the past 6 months (pattern and amount of it), dietary intake change (relative to normal), gastrointestinal symptoms >2 weeks (nausea, vomiting, diarrhea, anorexia, etc.), functional capacity (energy level: daily activities, bedridden), and metabolic demands of underlying condition. Physical examination explores muscle, fat mass, and the existence of edema. Each feature is noted as normal, mild, moderate, or severe according to clinician's subjective impression. Finally, the clinician awards a subjective grade: A, well nourished; B, moderately malnourished; and C, severely malnourished. Scoring may predict development of infection and post operatory complications. It has been validated in different conditions and it does not require laboratory testing. It has been considered a gold standard to which new screening tools have been compared. However, health-care providers need a short training to use it so that the results coincide among different observers. Its administration takes some time, and it is not sensitive enough to use in following nutritional status changes.
3. *Mini nutritional assessment* (*MNA*), described in 1987, aimed for individuals over 65 to assess nutritional status as a part of the standard geriatric evaluation in outpatient settings, nursing homes, and hospitals [12]. It contains six initial questions that work as a screening tool [13]. If the individual is at risk of malnutrition, 12 further questions actually perform a nutritional assessment, divided into anthropometrics, general, dietary, and subjective assessment (Fig. 2.2). Therefore, this tool carries out both a screening and an assessment of the individual. The price to pay is that it takes longer to administer than many other screening tools. This tool has been used in many papers dealing with geriatric patients in multiple care settings. It is difficult to administer in patients on enteral or parenteral nutrition and in those unable of communicating a subjective assessment. On the other hand, it could be used for following up nutritional interventions in the elderly.
4. *Malnutrition screening tool* (*MST*) is a simple tool with three questions related to unintentional weight loss and reduced appetite [14]. It was developed and validated in medical/surgical adult hospital patients in Australia (Table 2.2). The authors started to work with 21 nutritional screening questions and chose SGA as the reference method for defining malnutrition. In this way, they selected three questions that had the best sensitivity and specificity at predicting nutritional

Table 2.1 Subjective global assessment (Adapted from Detsky et al. [11], Reprinted with permission from J Parenter Enter Nutr, 11, AS Detsky et al., What is subjective global assessment of nutritional status? 8–13, 1987. SAGE Publications)

A. History
1. Weight change
Overall loss in past 6 months: amount: …… kg; % loss: ……
Change in past 2 weeks: ☐ Increase
☐ No change
☐ Decrease
2. Dietary intake change (relative to normal)
☐ No change
☐ Change
duration: …… weeks
type:
☐ Suboptimal solid diet
☐ Full liquid diet
☐ Hypocaloric liquids
☐ Starvation
3. Gastrointestinal symptoms (that persisted for >2 weeks)
☐ None
☐ Nausea
☐ Vomiting
☐ Diarrhea
☐ Anorexia
4. Functional capacity
☐ No dysfunction (e.g., full capacity)
☐ Dysfunction
duration: …… weeks
type:
☐ Working suboptimally
☐ Ambulatory
☐ Bedridden
5. Disease and its relation to nutritional requirements
Primary diagnosis (specify): ……
Metabolic demand (stress): ☐ No stress
☐ Low stress
☐ Moderate stress
☐ High stress
B. Physical (for each trait specify: 0 = normal, 1+ = mild, 2+ = moderate, 3+ = severe)
…… Loss of subcutaneous fat (triceps, chest)
…… Muscle wasting (quadriceps, deltoids)
…… Ankle edema
…… Sacral edema
…… Ascites
SGA rating (select one)
☐ A. Well nourished
☐ B. Moderately (or suspected of being) malnourished
☐ C. Severely malnourished

status according to the SGA. A cutoff score of 2 was established to indicate malnutrition out of a possible higher score of 7. A weekly reassessment was recommended for patients not at risk of malnutrition, and those identified as "at risk"

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.
Add the numbers for the screen. If score is 11 or less, continue with the assessment to gain a Malnutrition Indicator 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 3kg (6.6lbs)
1 = does not know
2 = weight loss between 1 and 3kg (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 ☐

F 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 ☐

Screening score (subtotal max. 14 points) ☐☐
12-14 points: Normal nutritional status
8-11 points: At risk of malnutrition
0-7 points: Malnourished
For a more in-depth assessment, continue with questions G-R

Assessment

G Lives independently (not in nursing home or hospital)
1 = yes 0 = no ☐

H Takes more than 3 prescription drugs per day
0 = yes 1 = no ☐

I Pressure sores or skin ulcers
0 = yes 1 = no ☐

J How many full meals does the patient eat daily?
0 = 1 meal
1 = 2 meals
2 = 3 meals ☐

K Selected consumption markers for protein intake
- At least one serving of dairy products (milk, cheese, yoghurt) per day yes ☐ no ☐
- Two or more servings of legumes or eggs per week yes ☐ no ☐
- Meat, fish or poultry every day yes ☐ no ☐

0.0 = if 0 or 1 yes
0.5 = if 2 yes
1.0 = if 3 yes ☐.☐

L Consumes two or more servings of fruit or vegetables per day?
0 = no 1 = yes ☐

M How much fluid (water, juice, coffee, tea, milk...) is consumed per day?
0.0 = less than 3 cups
0.5 = 3 to 5 cups
1.0 = more than 5 cups ☐.☐

N Mode of feeding
0 = unable to eat without assistance
1 = self-fed with some difficulty
2 = self-fed without any problem ☐

O Self view of nutritional status
0 = views self as being malnourished
1 = is uncertain of nutritional state
2 = views self as having no nutritional problem ☐

P In comparison with other people of the same age, how does the patient consider his / her health status?
0.0 = not as good
0.5 = does not know
1.0 = as good
2.0 = better ☐.☐

Q Mid-arm circumference (MAC) in cm
0.0 = MAC less than 21
0.5 = MAC 21 to 22
1.0 = MAC greater than 22 ☐.☐

R Calf circumference (CC) in cm
0 = CC less than 31
1 = CC 31 or greater ☐

Assessment (max. 16 points) ☐☐.☐
Screening score ☐☐.☐
Total Assessment (max. 30 points) ☐☐.☐

Malnutrition Indicator Score
24 to 30 points ☐ Normal nutritional status
17 to 23.5 points ☐ At risk of malnutrition
Less than 17 points ☐ Malnourished

References
1. Vellas B, Villars H, Abellan G, *et al.* Overview of the MNA® - Its History and Challenges. *J Nutr Health Aging.* 2006; **10:456**-465.
2. 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
3. Guigoz Y. The Mini-Nutritional Assessment (MNA®) Review of the Literature - What does it tell us? *J Nutr Health Aging.* 2006; **10**:466-487.

For more information: www.mna-elderly.com

Fig. 2.2 Mini nutritional assessment (MNA) (Reprinted with permission from Nestlé. Further information for MNA can be obtained from www.mna-elderly.com)

Table 2.2 Malnutrition screening tool (MST); a total score of ≥2 signifies patient at risk of malnutrition (Adapted from Ferguson et al. [14], Reprinted with permission from Nutrition 15, Ferguson M et al. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients, 458–64, 1999. Elsevier)

Question	Score
1: Have you lost weight recently without trying?	
No	0
Unsure	2
If yes, how much weight (kg) have you lost?	
1–5	1
6–10	2
11–15	3
>15	4
Unsure	2
2. Have you been eating poorly because of a decreased appetite?	
No	0
Yes	1

of malnutrition should receive a more detailed nutritional assessment, to decide the most appropriate nutritional intervention.

5. *Nutritional risk screening* (*NRS 2002*) uses unintentional weight loss, low BMI, disease severity, age >70 years, and impaired condition [15]. As seen in Table 2.3, two scores are calculated: one for impaired nutritional status and one for severity of disease. These scores are then added up and a final score is obtained. If the patient is over 70 years of age, 1 point is added to the final score. A score of ≥3 indicates the need to start nutritional support. This tool anticipates several scenarios, patients who are either severely malnourished (score of 3 for impaired nutritional status) and/or severely ill (score of 3 for severity of disease) or moderately undernourished and mildly ill (2 + 1, total score of 3) or mildly undernourished and moderately ill (1 + 2, total score of 3). In any case, the tool makes recommendations about a nutritional care plan for those patients with a score ≥3, from administration of extra food, oral supplements, tube feeding, to parenteral nutrition. One weakness of this tool is the subjective assessment of severity of illness, which can cause some confusion among clinicians. The tool was validated retrospectively, showing that it was capable of distinguishing those patients with a positive clinical outcome due to nutritional intervention from those that showed no benefit of nutritional support. Prospectively, patients with complications who received intervention according to NRS 2002 results had significant shorter length of stay, compared to those who received no nutritional intervention [16]. It is interesting to point out that the main goal of the developers of this screening tool was to identify those patients who will benefit from nutritional intervention rather than classifying them according to the risk of malnutrition.
6. *Malnutrition universal screening tool* (*MUST*) was developed in 2003 by the Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition (BAPEN) [17]. According to the intention of its developers, it eases the communication of nutritional status across different care settings, since it has been validated in primary care, home care, acute care, and long-term care, which has the benefit of allowing comparable nutritional screening data across care settings. In hospitals, MUST predicts length of hospital stay, type of

Table 2.3 Nutritional risk screening (NRS 2002) (Adapted from Kondrup et al. [15], Reprinted with permission from Clinical Nutrition, 22, Kondrup J, et al., ESPEN Working Group, Nutritional Risk screening (NRS 2002): a new method based on analysis of controlled clinical trials, 321–36, 2003. Elsevier)

Initial screening			
Is BMI <20.5?		Yes	No
Has the patient lost weight within the last 3 months?		Yes	No
Has the patient had a reduced dietary intake in the last week?		Yes	No
Is the patient severely ill? (e.g. in intensive therapy)		Yes	No
If the answer is Yes to any question, proceed to Formal Screening section below *If the answer is No to all questions, the patient is re-screened at weekly intervals. If the patient e.g. is scheduled for a major operation, a preventive nutritional care plan is considered to avoid the associated risk status*			
Formal screening			
Impaired nutritional status		*Severity of disease* (*~ stress metabolism*)	
Absent Score 0	Normal nutritional status	*Absent* Score 0	Normal nutritional requirements
Mild Score 1	Weight loss >5% in 3 months *or* Food intake below 50–75% of normal requirement in preceding week	*Mild* Score 1	Hip fracture, patients admitted to hospital due to complications associated with a chronic disease such as cirrhosis, COPD, chronic hemodialysis, diabetes, oncology
Moderate Score 2	Weight loss >5% in 2 months *or* BMI 18.5-20.5 with impaired general condition *or* Food intake 25-50% of normal requirement in preceding week	*Moderate* Score 2	Patient confined to bed due to illness, such as major abdominal surgery, stroke, severe pneumonia, hematologic malignancy
Severe Score 3	Weight loss >5% in 1 month (~>15% in 3 months) *or* BMI <18.5 with impaired general condition *or* Food intake 0–25% of normal requirement in preceding week	*Severe* Score 3	Head injury, bone marrow transplantation, intensive care patients (APACHE >10)
An additional score of 1 is added to patients ≥70 years of age; a composite score of ≥3 is suggestive of a patient nutritionally at risk and necessitating nutritional support			

discharge destination, and mortality. In community care, malnutrition scores predict rate of hospital admissions and general practitioner visits. It also shows that appropriate nutritional intervention improves outcome. MUST uses unintentional weight loss, BMI, disease severity, and problems with food intake to classify malnutrition risk (Fig. 2.3). A score ≥2 indicates malnutrition risk. This tool recommends an action plan for the treatment of patients at risk of malnutrition, either with local management protocols or with some general pieces of advice.

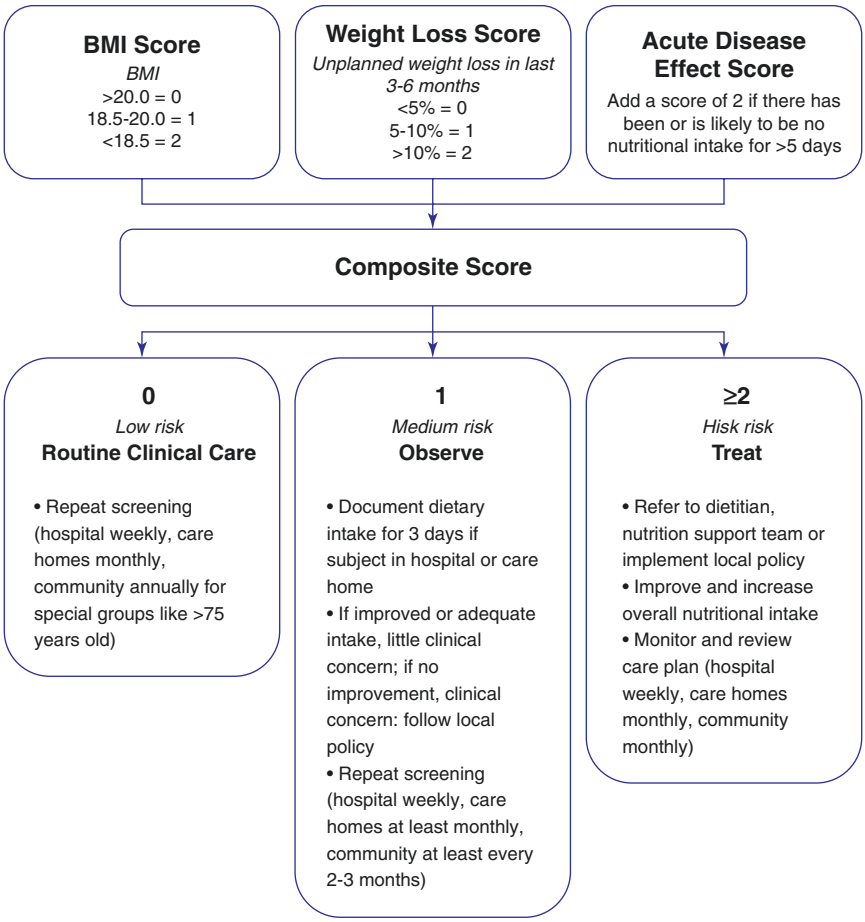

Fig. 2.3 Malnutrition universal screening tool (MUST) algorithm for adults (Adapted from Stratton et al. [17], Reprinted with permission from Br J Nutr, 92, RJ Stratton et al., Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the "malnutrition universal screening tool" ('MUST') for adults. 799–808, 2004. Cambridge University Press). Further information can be obtained from www.bapen.org.uk

7. *Short nutritional assessment questionnaire* (*SNAQ*) consists of three questions, unintentional weight loss, appetite loss, and use of nutritional supplements or tube feeding [18] (Fig. 2.4). It was developed in the Netherlands and published in 2005. In this country universal nutritional screening is now mandatory in hospitals. The SNAQ is administered by nurses after patient admission to the hospital. Patients are classified as well nourished, moderately malnourished, and severely malnourished. For those with malnutrition, there is a treatment plan ranging from enrichment of meals to parenteral nutrition, guided by the evaluation of a dietitian. With the SNAQ, patients identified as malnourished had a significantly higher care complexity and reduced quality of life, physical

Fig. 2.4 Short nutritional assessment questionnaire (SNAQ) (Reprinted with permission from Dutch Malnutrition Steering Group. Further information can be obtained from http://www.fightmalnutrition.eu)

functioning, and fat-free mass index [19]. In a further expansion of their initiative, the Dutch authors have developed specific nutritional screening tools for people over 65 years old and for people living in residential care (Figs. 2.5 and 2.6) [20].

The description and explanation of these tools have had an academic purpose. There is not a perfect nutritional screening tool. It is conceivable that the different tools may detect different rates of malnutrition, since their basic assumptions, target population, and normal range values were different.

A systematic review of screening tools for the hospital setting concluded that currently we do not have one single screening or assessment tool that is capable of adequate nutritional screening as well as predicting poor nutrition-related outcome. Further studies comparing different tools within one patient population were recommended, and development of new tools was discouraged [21].

However, readers are encouraged to choose the tool that best adapts to their clinical practice. It is worth remembering that ESPEN proposes screening methods NRS 2002, MUST, and MNA, while the American Society for Parenteral and Enteral Nutrition (ASPEN) adds to these methods MST and SNAQ6 [22]. Some methods are preferred in the countries where they have been developed, like MUST in United Kingdom, MST in Australia, or SNAQ in the Netherlands. Important criteria to be taken into consideration in this election are what population will be evaluated by a particular tool and the relation with prognosis or with therapeutic response to

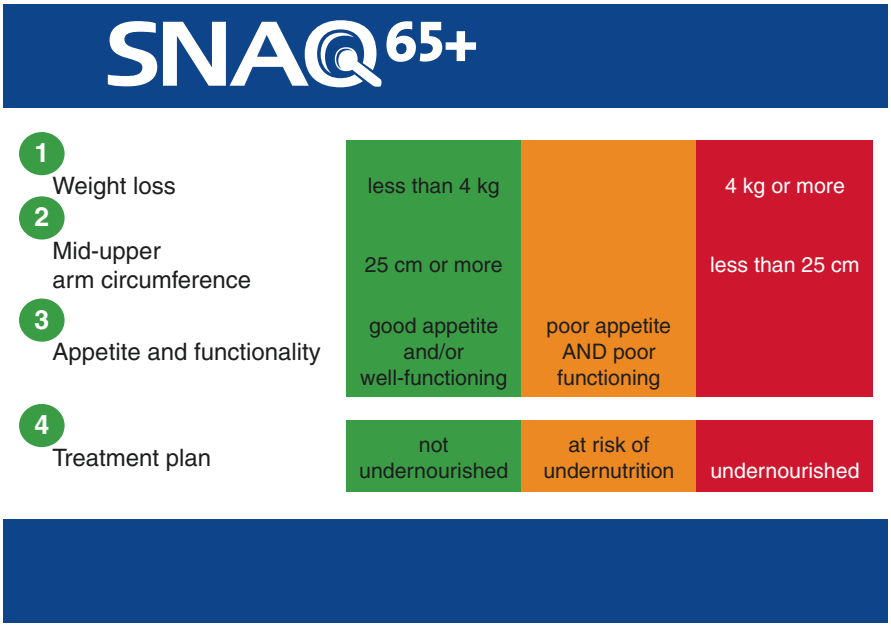

Fig. 2.5 Short nutritional assessment questionnaire for people over 65 years old (SNAQ 65+) (Reprinted with permission from Dutch Malnutrition Steering Group. Further information can be obtained from http://www.fightmalnutrition.eu)

nutritional intervention. These tools have been divided into comprehensive or quick and easy tools. Comprehensive screening tools, like MUST and NRS 2002, are more time demanding and need a better training of nurses. With the incorporation of electronic medical records to clinical practice, it is easier to calculate BMI and percentage of unintentional weight loss. On the other hand, quick and easy screening tools, like MST and SNAQ, were not developed for diagnostic purposes and do not allow following patients in time. However, for the objective of identifying patients at risk of malnutrition, they could be as useful as the comprehensive tools [23].

It is essential that the screening tool chosen in a particular clinical setting be linked to an algorithm that indicates what will be the next steps and the protocol of periodic reassessment of patients. The result of the screening and assessment has to be incorporated to the medical record, making it easier that the diagnosis of malnutrition, if exists, appears in the discharge report and in the diagnostic codes. The reimbursement obtained by the health-care organization, either hospital or outpatient clinic, will be increased if the nutritional component of the clinical care is registered.

Nutritional screening should be universal and mandatory for patients admitted to the hospital, but it should also be performed in the ambulatory setting and repeated according to the nature of the underlying process. Some authors have stated that it should be part of routine care, in the same way as assessing physiologic measures,

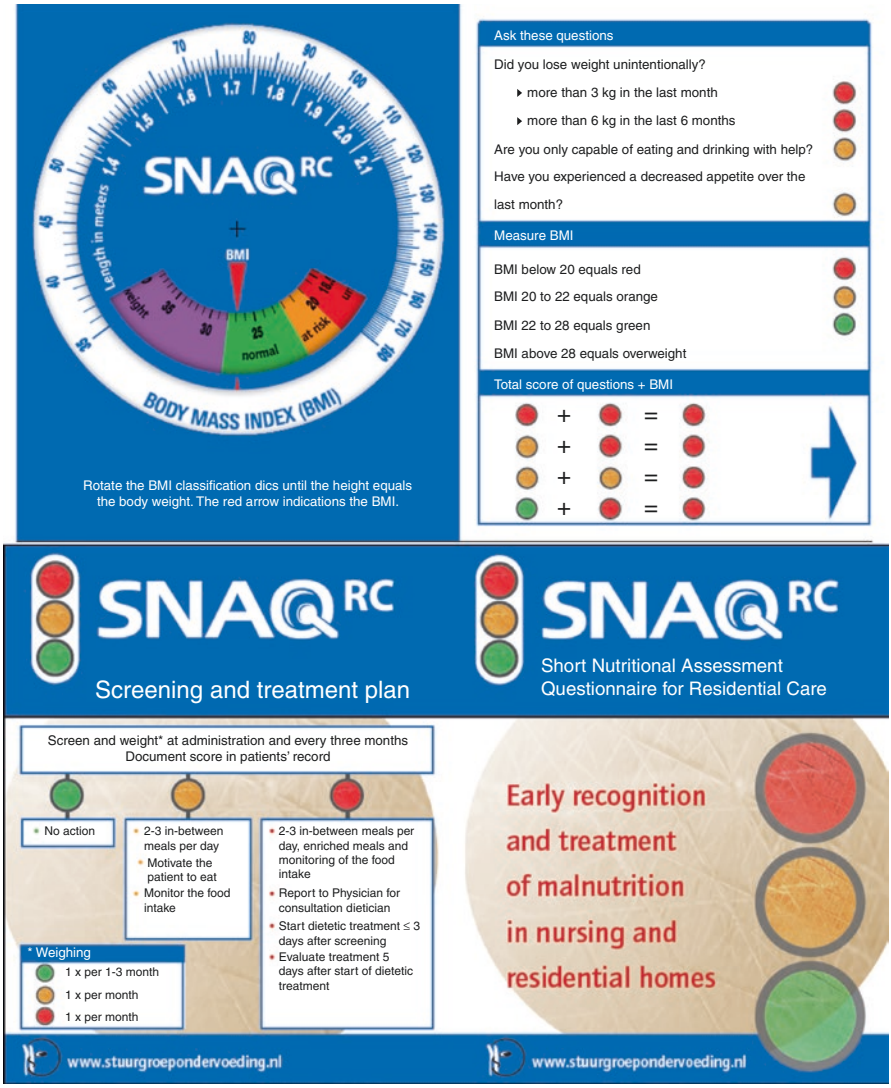

Fig. 2.6 Short nutritional assessment questionnaire for residential care (SNAQ^{RC}) (Reprinted with permission from Dutch Malnutrition Steering Group. Further information can be obtained from http://www.fightmalnutrition.eu)

such as body temperature or blood pressure, starting from the time of patient's admission to the hospital or when the patient is seen in the outpatient clinic [23]. A good initiative is to include nutritional screening among the quality indicators of the medical center. Its different health-care providers will be trained in the correct administration of the screening tool approved for use in the center, although the professionals in charge of carrying out the nutritional screening have to be clearly identified.

Neurological disorders may have specific elements that have an influence on nutritional screening and assessment. They will be extensively discussed in the next chapters. Here we can just mention some factors. Malnutrition per se may cause muscular atrophy, especially of muscular fiber type II. It may cause dysfunction of muscles participating in swallowing, breathing, or standing and walking. These alterations are added to those developed in the course of the underlying neurological disease.

Patients with neurological diseases may have difficulties for standing, making it difficult in obtaining a reliable height and weight measurement. Equations used to estimate energy expenditure include height and weight as variables. If the validity of these equations in neurological diseases may be problematic [24], the inability of getting correct data of height and weight augments the difficulty of the task of estimating energy and protein requirements in these patients. The height may be estimated based on arm span, knee height, or length of the forearm (ulna). Several knee height equations have been developed with data coming from different communities, with different race mixtures [25]. Clinicians should determine if it is acceptable to use them in their clinical setting. Similarly, the tables that allow estimating the height based on the length between the point of the elbow (olecranon process) and the midpoint of the prominent bone of the wrist (styloid process) (left side if possible) have to be valid in the community from where the patients come. One example of these tables comes in the MUST booklet, freely available on BAPEN website.

When it is not possible to determine BMI by lack of data of height or weight, it can be estimated from mid-upper arm circumference (MUAC), which is quite easy to measure. The subject's left arm should be bent at the elbow at a 90° angle, with the upper arm held parallel to the side of the body. In practical terms, the explorer should measure the distance between the bony protrusion on the shoulder (acromion) and the point of the elbow (olecranon process). The midpoint should then be marked, and the measurement be performed around the upper arm at this point. There are different equivalents in MUST and in SNAQ 65:

In MUST:

- If MUAC is <23.5 cm, BMI is likely to be <20 kg/m^2.
- If MUAC is >32.0 cm, BMI is likely to be >30 kg/m^2.

In SNAQ 65:

- If MUAC is <23.5 cm, BMI is likely to be <18.5 kg/m^2.
- If MUAC is 23.5–25.0 cm, BMI is likely to be 18.5–20 kg/m^2.
- If MUAC is >25.0 cm, BMI is likely to be >20 kg/m^2.

Again, it is necessary to be certain that these cutoff limits are valid in the population we work with. As we will discuss below, muscular measurements may be altered not only by malnutrition but also by the underlying neurological disorder.

Even when height and weight can be measured, the desirable range of BMI in a particular neurological disease may be different from healthy individuals. As an example, in amyotrophic lateral sclerosis, the ideal BMI range is 30–35 kg/m^2,

because it is associated with a better overall survival [26]. This casts some doubt on the validity of the ranges of BMI used in the above-described screening tools in patients with this disease. There are no similar data in other neurological disorders, but we may assume a similar scenario.

2.3 Nutritional Assessment

After nutritional screening, following the identification of individuals at risk, the next step is nutritional assessment that will direct to choosing the best intervention to correct the malnutrition status. It is a detailed evaluation of nutritional status and nutritional needs, ideally performed by a dietitian/nutritionist or other trained health-care provider. It estimates functional status, diet intake, and body composition compared to normal populations. In the specific case of patients with neurological disorders, it is well known that they are at risk of both undernutrition and obesity.

There is no universally accepted method of nutritional assessment. Many factors need to be taken into consideration. It has to be based on a comprehensive approach. Symptoms, signs, and biochemical, anatomical or functional measures may be ambiguous with insufficient specificity and sensibility. Therefore, clinicians have to interpret findings obtained in each individual according to the patient's overall situation. As an example, it is not adequate to say that a patient has to receive artificial nutrition because he/she has a low serum albumin concentration. A broader assessment and evaluation of the perspectives for a sufficient or insufficient intake plus a consideration of the gastrointestinal tract function would be key elements to establish the indication of that nutritional intervention.

Items frequently covered in nutritional assessment are:

- Medical history, with emphasis on details regarding weight change, diseases with an impact on nutritional status, hospitalizations, surgery, changes in appetite, smell and taste alterations, dysphagia, intestinal dysmotility, alcohol or other addictions, medications, food-drug interactions, level of physical activity, daily living activities, etc.
- Dietary history, with evaluation of what and how much the person is eating, as well as habits, beliefs, and social conditions, availability and preparation of food; eating independence; cultural, religious, and ethnic food preferences; age-related nutritional issues, etc. Usual tools for dietary assessment are:
  - 24-h recall.
  - Food frequency questionnaire.
  - Food diary.
  - In patients with neuromuscular disorders, it is important to analyze the ability of feeding themselves, how much time it takes to eat each meal, early fatigue, safety of swallowing, etc.
- Social history, economic status, occupation, education level, living and cooking arrangements, and mental status.

- Physical examination, looking for findings of soft-tissue wasting, hydration status, and evidence of vitamin and mineral deficiencies, knowing that most signs indicate more than one nutrient deficiency and that signs are generally not observed unless severe deficiencies exist.
- Anthropometry:
  - Weight: usual, current, adjusted, ideal, and weight variation history
  - Height: actual or estimated by different methods, as described above
  - BMI
  - Skinfold thickness: triceps, biceps, subscapular, suprailiac. It estimates subcutaneous fat stores to assess total body fat.
  - Circumferences: arm, calf, and waist. It estimates skeletal muscle mass (somatic protein stores) and body fat distribution, respectively. It is important to remember that the underlying neurological disease or immobilization may alter muscular mass per se and cause muscular atrophy. Therefore, body composition techniques may better reflect the nutritional status than BMI or muscular circumferences in the arm or in the calf.
- Body composition: bioimpedance analysis, computed tomography, magnetic resonance, dual-energy X-ray absorptiometry, and air displacement plethysmography.
- Functional measures: handgrip dynamometry and gait speed. Neurological muscular atrophy may alter the results, and they can be of little use in these disorders.
- Laboratory parameters:
  - Serum proteins, such as albumin, prealbumin, retinol-binding protein. They are synthesized in the liver and behave like negative acute-phase reactants with reduced levels during systemic inflammation. Other reasons for abnormal results are renal and hepatic disease, wounds and burns, cancer, and hydration status. However, in the absence of inflammation or these disorders, a low concentration of these proteins may correlate with malnutrition
  - C-reactive protein.
  - Cholesterol.
  - Electrolytes.
  - Hemogram.
  - Vitamin and minerals.
- Evaluation of nutritional requirements to check if current food intake meets the estimated requirements of the patient.

In the nutritional assessment of any patient with a neuromuscular disease, it is essential to check his/her *hydration status*. Many factors may explain why these patients are at risk of dehydration. Some of them are not able to have access to liquids. Others present difficulties in swallowing liquids and are afraid of penetration of liquids into the respiratory airway during swallowing. Comorbidities, such as diabetes mellitus, diabetes insipidus, Addison's disease, chronic heart failure or renal failure, and some drug therapies, may lead to abnormal water losses, or water restriction, adding further troubles for maintaining a stable hydration status.

A negative hydric balance has clinical consequences in a short term. Many usual symptoms presented by patients with neuromuscular disorders get worse. Dehydration causes asthenia, dizziness, constipation, hypotension, renal failure, somnolence, lower consciousness, and even coma. Dryness of the oral mucosa may worsen dysphagia, with lower production of saliva, changes in the formation of the bolus, and development of oral infectious complications.

Hydration status has to be evaluated periodically after the diagnosis of the neurological disease, especially when symptoms and signs of dysphagia appear. Healthcare providers have to estimate hydric needs of patients and take the measures to warrant that they receive them in an effective and safe way.

2.4 Diagnostic Criteria of Malnutrition

The result of nutritional assessment will be a diagnosis of malnutrition that should be added in the medical record and in the discharge report, along with the nutritional intervention that has been recommended and implemented. Despite the existence of an international consensus to describe the three main malnutrition syndromes, there are different sets of diagnostic criteria established by ASPEN and ESPEN.

The Academy of Nutrition and Dietetics and ASPEN have extended this diagnostic construct with a recent consensus document highlighting characteristics recommended for the identification and documentation of malnutrition in adults [27].

The proposed criteria are:

- *Insufficient energy intake*: % nutrients consumed/administered vs. requirement
- *Unintended weight loss*: can occur at any BMI
- Physical examination:
  - Loss of *muscle mass*
  - Loss of *subcutaneous fat*
  - Evidence of *fluid accumulation* (localized or generalized)
- Diminished physical function:
  - *Handgrip strength*
  - SPPB (short physical performance battery) for elderly patients
  - Other

In bold the six characteristics that are used to diagnose malnutrition are indicated. A positive finding in any two characteristics indicates malnutrition. For each characteristic, there are different thresholds for both severe and no severe (moderate) malnutrition, in the three syndromes of malnutrition, acute illness or injury-related malnutrition, chronic disease-related malnutrition, and social- or environmental-related malnutrition (Tables 2.4 and 2.5). Specific thresholds for each situation can be found in the tutorial prepared by Malone and Hamilton, which provides very useful recommendations for the assessment of edema and of body fat and muscle mass in specific anatomic areas to help for an objective evaluation of subcutaneous fat and muscle mass loss, respectively [28].

Table 2.4 Severe malnutrition in adults (Adapted from Academy of Nutrition and Dietetics and ASPEN clinical characteristics criteria [27]. Reprinted with permission from J Acad Nutr Diet, 112, White JV et al., Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition), 730–8, 2012. Elsevier)

ICD-9 code 262	Acute illness/injury setting	Chronic illness setting	Social/environmental circumstances setting
Energy intake	≤50% of estimated requirement for ≥5 days	<75% of estimated requirement for ≥1 month	≤50% of estimated requirement for ≥1 month
Weight loss	>2%/1 week >5%/1 month >7.5%/3 months	>5%/1 month >7.5%/3 months >10%/6 months >20%/1 year	>5%/1 month >7.5%/3 months >10%/6 months >20%/1 year
Body fat	Moderate loss	Severe loss	Severe loss
Muscle mass	Moderate loss	Severe loss	Severe loss
Fluid accumulation	Moderate to severe	Severe	Severe
Grip strength	Measurably reduced (not recommended in intensive care units)	Measurably reduced	Measurably reduced

Table 2.5 Non-severe (moderate) malnutrition in adults (Adapted from Academy of Nutrition and Dietetics and ASPEN clinical characteristics criteria [27]. Reprinted with permission from J Acad Nutr Diet, 112, White JV et al., Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition), 730–8, 2012. Elsevier)

ICD-9 code 263.0	Acute illness/injury setting	Chronic illness setting	Social/environmental circumstances setting
Energy intake	<75% of estimated requirement for >7 days	<75% of estimated requirement for ≥1 month	<75% of estimated requirement for ≥3 months
Weight loss	1–2%/1 week 5%/1 month 7.5%/3 months	5%/1 month 7.5%/3 months 10%/6 months 20%/1 year	5%/1 month 7.5%/3 months 10%/6 months 20%/1 year
Body fat	Mild loss	Mild loss	Mild loss
Muscle mass	Mild loss	Mild loss	Mild loss
Fluid accumulation	Mild	Mild	Mild
Grip strength	Not applicable	Not applicable	Not applicable

The Academy of Nutrition and Dietetics and ASPEN recommend ICD-9 code 262 for the diagnosis of severe protein-calorie malnutrition and ICD-9 code 263.0 for moderate (no severe) malnutrition. These ICD-9 codes have definitions that best match the malnutrition criteria for severe and moderate (no severe) malnutrition according to the consensus document. Nevertheless, the criteria developed in support of the diagnosis of severe and no severe malnutrition may be adapted in the

future according to further development and testing. The equivalent ICD-10 codes would be E43 and E44, respectively.

ESPEN has lately proposed some criteria for the diagnosis of disease-related malnutrition [29]. The objective of ESPEN statement was to provide malnutrition diagnostic criteria that are independent of etiology, in contrast with ASPEN, as we have just seen. A consensus group was in charge of achieving objective, simple, clear, and generally diagnostic criteria of malnutrition. Several agreements were made by this group. Food intake and appetite were contemplated as important items for screening, but they were not considered as required diagnostic criteria, because any reduction would be reflected by weight loss. Visceral proteins, like serum albumin or prealbumin, were thought of as markers of inflammation, disease severity, and outcome with little specificity as nutritional markers. In relation to inflammation, it is seen more as an etiologic factor than a defining criterion of malnutrition, and inflammation markers were not included in the criteria.

As ASPEN, ESPEN recommends universal screening, without advising any particular tool. Those patients at risk of malnutrition will be diagnosed with malnutrition if they satisfy the following criteria:

I. Patient fulfills criteria for being "at risk" of malnutrition by any validated risk screening tool.

II. Patient meets the criteria of alternative 1 or 2:

Alternative 1:

- BMI <18.5 kg/m^2

Alternative 2:

- Weight loss (unintentional) >10% indefinite of time or >5% over the last 3 months combined with either
  - BMI <20 kg/m^2 if <70 years of age or <22 kg/m^2 if ≥70 years of age or
  - Fat-free mass index (FFMI) <15 and 17 kg/m^2 in women and men, respectively.

Therefore, according to ESPEN, the three variables that most accurately reflect malnutrition are weight loss (generally self-reported and at risk of recall bias), reduced BMI, and reduced FFMI. Nevertheless, their criteria have been criticized because they are very strict, leaving out patients with lower weight loss or with higher BMI, if they were previously obese. Furthermore, in some European countries, reimbursement of oral nutritional supplements is linked to a diagnosis of malnutrition, which is generally less stringent. The ESPEN consensus group repeatedly insisted on the need of considering risk of malnutrition as a disease category with its own code in the ICD and in the DRG system. That would solve the problem of indication for reimbursement. A different option is to apply to malnutrition a similar approach as in chronic renal failure, where five different stages have been established. With this concept in mind, the ESPEN criteria would be like restricting the concept of chronic renal failure only to those patients on dialysis. On the other hand,

if the concept of malnutrition stages were accepted, it would be easier that earlier stages or the risk category of malnutrition could be diagnosed and reimbursed.

Recently, a study has described for the first time the prevalence of malnutrition according to the ESPEN definition in four diverse populations, acutely ill middle-aged patients, geriatric outpatients, healthy old individuals, and healthy young individuals [30]. Subjects were screened for risk of malnutrition using the SNAQ. Screening identified 30, 10, 0.5, and 0% as being at risk of malnutrition, respectively. The prevalence of malnutrition was 0% in healthy young, 0.5% in healthy old individuals, 6% in geriatric outpatients, and 14% in the acutely ill middle-aged patients. Prevalence of low FFMI was observed in all four populations (14–33%), but was not always associated with weight loss (0–13%). Interestingly, participants classified as malnourished based only on low BMI <18.5 kg/m^2 were mainly acutely ill middle-aged patients. It can be assumed that the underlying disease was responsible for the weight loss. Conversely, that low BMI was observed very infrequently in geriatric outpatients and healthy old individuals. This may be due to the increase of BMI with age noticed in many epidemiological studies. In the first three groups, low FFMI was better associated to unintentional weight loss. In consequence, measuring FFMI in addition could detect malnutrition better than only BMI. The problem is to find reliable methods of body composition analysis available in routine clinical practice.

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