REVIEW

Objective Data Assessment (ODA) Methods as Nutritional Assessment Tools

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Abstract : Nutritional screening and assessment should be a standard of care for all patients because nutritional management plays an important role in clinical practice. However, there is no gold standard for the diagnosis of malnutrition or undernutrition, although a large number of nutritional screening and assessment tools have been developed. Nutritional screening and assessment tools are classified into two categories, namely, subjective global assessment (SGA) and objective data assessment (ODA). SGA assesses nutritional status based on the features of medical history and physical examination. On the other hand, ODA consists of objective data provided from various analyses, such as anthropometry, bioimpedance analysis (BIA), dual-energy X-ray absorptiometry (DEXA), computed tomography (CT), magnetic resonance imaging (MRI), laboratory tests, and functional tests. This review highlights knowledge on the performance of ODA methods for the assessment of nutritional status in clinical practice. J. Med. Invest. 62 : 119-122, August, 2015

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INTRODUCTION

Since nutritional management plays an important role in clinical practice, nutritional screening and assessment should be a standard of care for all patients. In fact, undernutrition and malnutrition are associated with decreased survival, worse clinical outcome and quality of life, and increased therapy toxicity in cancer patients. However, there is no gold standard for the diagnosis of malnutrition, although a large number of nutritional screening and assessment tools have been developed. Nutritional screening has to be performed routinely and systematically in a very practical and efficient manner. On the other hand, nutritional assessment has to be individualized to provide information on the grade of malnutrition and its causes. In addition, nutritional assessment is a more complex process, involving the use of several measures to determine nutritional status. It is important for medical staff members to understand the advantages and disadvantages of each nutritional assessment tool. This review is intended to update knowledge on the performance of objective data assessment methods for the assessment of nutritional status in clinical practice.

1. SUBJECTIVE GLOBAL ASSESSMENT (SGA) AND OBJECTIVE DATA ASSESSMENT (ODA)

Nutritional screening and assessment tools are classified into two categories, namely, subjective global assessment (SGA) and objective data assessment (ODA) (Table 1). SGA assesses nutritional status based on the features of medical history and physical examination and is a nutritional assessment tool widely used in hospital clinical practice, even though it has some limitations in relation to its use. On the other hand, ODA consists of objective data provided from various analyses, such as anthropometry, bioimpedance analysis (BIA), dual-energy X-ray absorptiometry (DEXA), computed tomography (CT), magnetic resonance imaging (MRI), laboratory tests, and functional tests. Nutritional screening should not be an expensive and time-consuming process, and should involve simple methods, such as SGA, which are thought to be adequate to identify patients who need nutritional intervention. In contrast, nutritional assessment should be a combination of various parameters because no single parameter has been shown to be useful in all patients. Most nutritional assessment tools are imperfect ; therefore, medical staff members need to understand the features of each method.

2. COMPONENTS OF OBJECTIVE DATA ASSESSMENT (ODA)

ODA methods as nutritional assessment tools are divided into four groups : anthropometry, laboratory tests, evaluation of immune competence, and functional tests.

1) Anthropometry

Body weight is an important basic anthropometry parameter. In addition, body mass index (BMI), which is expressed as body weight/height squared (kg/m^2), is also a well-known index of nutritional status. However, many clinicians recognize that they are rather inaccurate measures, especially for elderly people and patients with specific clinical conditions.

Anthropometric measurements of circumference or skin folds represent simple, noninvasive, and inexpensive ways to assess nutritional status. Arm circumference (AC) reflects arm muscle, and triceps skinfold (TSF) thickness reflects upper arm subcutaneous fat. Although these measurements seem to be relatively easy, considerable skill is required to obtain reliable results and there are individual differences of operators. The individual variation makes it difficult for monitoring changes in nutritional status.

Recently, the importance of body composition has been highlighted. It is clear that changes in body composition may occur

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Table 1 : SGA and ODA

Subjective global assessment (SGA)	Objective data assessment (ODA)
• Nutritional assessment based on features of the history and physical examination • Widely used in hospital clinical practice • Mainly used for the purpose of nutritional screening	• Various analyses such as anthropometry, bioimpedance analysis (BIA), dual-energy X-ray absorptiometry (DEXA), computed tomography (CT), magnetic resonance imaging (MRI), laboratory tests, and functional tests are included. • Mainly used for the purpose of nutritional assessment

independently from changes in body weight or BMI. While short-term changes in body weight usually reflect changes in fluid compartments, long-term changes also reflect changes in tissue mass. Measurements of body composition are fundamental for an in-depth evaluation of nutritional status. The measurement of body composition allows documenting the efficiency of nutritional support, choosing nutritional therapies, and evaluating their efficacy and putative toxicity. In addition, a concept called sarcopenic obesity is also closely related to body composition (1).

As shown in Figure 1, several models have been developed for body composition analysis. In the two compartment model, body weight can be considered to consist of fat mass (FM) and free-fat mass (FFM). In the frequently used three compartment model, body weight can be considered to consist of FM, body cell mass (BCM), and extra-cellular mass (ECM). In the four-compartment model, body weight distinguishes fat, protein, mineral, and water. Three compartments are measured by various methods, while four compartments are calculated. Because BCM is the living, actively metabolizing part of the organism, consisting mainly of muscle, its size and integrity are crucial for health. The aim of nutritional therapy should be to maintain or increase BCM.

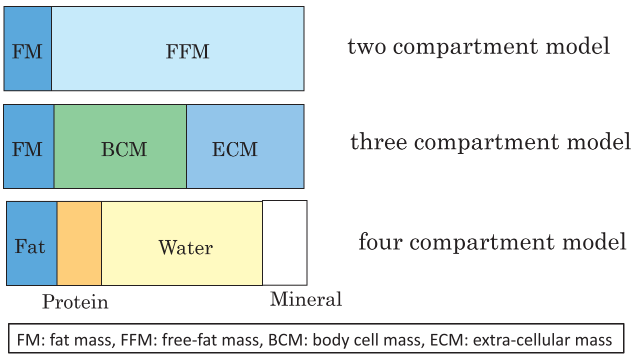

Figure 1 : Compartment models
In the two compartment model, body weight can be considered to consist of fat mass (FM) and free-fat mass (FFM). In the three compartment model, body weight can be considered to consist of FM, body cell mass (BCM), and extra-cellular mass (ECM). In the four compartment model, body weight distinguishes fat, protein, mineral, and water. Three compartments are measured by various methods, while four compartments are calculated.

Table 2 summarizes the advantages and disadvantages of the body composition measurement methods discussed in this review. It is important that there is no single measurement method that allows for the measurement of all tissues and organs and no method is error-free. In addition, the more advanced techniques are less accessible and more costly. However, these methods collectively allow for the measurement of FM, FFM, bone mineral content, total body water (TBW), extracellular water (ECW), total adipose tissue, skeletal muscle mass, and ectopic fat depots. Body composition reflects nutritional intakes, losses, and needs over time. In fact, undernutrition, including FFM loss or lean body mass loss, is associated with worse clinical outcome (2) and quality of life, as well as increased chemotherapy-related side effects in patients with cancer (3).

a) Bioimpedance analysis (BIA)

BIA is a simple, cost-effective, and precise method for body composition analysis. Although the validity of BIA is influenced by sex, age, disease state, race, and ethnicity (4), FM, FFM, bone mineral content, TBW, ECW, skeletal muscle mass, BCM, and phase angle (PhA) can be estimated by BIA. TBW, ECW, and ECW/TBW are useful to describe fluid shifts and fluid balance and to explore variations in levels of hydration (5). In a healthy state, FFM is related to BCM, and the integrity of BCM determines health, including muscle function and immune response. In contrast, inflammatory activity and lack of nutritional intake decrease BCM. PhA, also known as a predictive health marker, should be considered as a screening tool for the identification of risk patients with impaired nutritional and functional status (6, 7). Its main disadvantage is that it is highly sensitive to changes in body water (overhydration or dehydration), leading to substantial errors in body composition estimates.

b) Dual energy X-ray absorptiometry (DEXA)

DEXA is a widely used and noninvasive measurement technique that can be applied in humans of all ages (8). DEXA systems provide whole-body and regional estimates of three main components : bone mineral, bone-free FFM, and FM. The advantages of DEXA are good accuracy and reproducibility, and that it provides for the assessment of regional body composition (9, 10). On the other hand, the disadvantage of DEXA is exposure to a small amount of radiation. In addition, hydration status may affect DEXA accuracy. Large changes in hydration (higher than 5%) can change the attenuation of fat-free soft tissue (11), causing an overestimation of FFM. DEXA estimates of FM are influenced by trunk thickness, with errors increasing as the individual's trunk thickness increases.

c) Computed tomography (CT)

CT is a gold standard imaging technique for body composition analysis at the tissue-organ level. Bone, skeletal muscle, and adipose tissue have specific Hounsfield unit ranges, allowing for their identification in cross-sectional images. Recently, body composition analysis using CT is often adopted in clinical practice (12, 13). On the other hand, the disadvantage of CT is that the radiation dose generated by CT is high. Exposing healthy individuals to this high radiation dose solely for the purpose of conducting body composition research may be inappropriate from an ethical point of view. Therefore, CT imaging can be used when images are obtained as a part of the medical diagnosis and have been digitally stored in the patient's medical record.

d) Magnetic resonance imaging (MRI)

MRI allows for the estimation of adipose tissue, skeletal muscle, and other internal tissues and organs. In addition, MRI has been used in quantifying the distribution of adipose tissue into visceral, subcutaneous, and more recently intermuscular depots (14, 15). An advantage of MRI is that the images are not acquired using

Table 2 : Body composition measurement methods

Measurement methods	Advantage	Disadvantage
Bioimpedance analysis (BIA)	simple, cost-effective and precise	highly sensitive to changes in body water (overhydration or dehydration)
Dual energy X-ray absorptiometry (DXA)	noninvasive, good accuracy and reproducibility	exposure to a small amount of radiation
Computed tomography (CT)	gold-standard imaging technique for body composition analysis at the tissue-organ level	high radiation dose
Magnetic resonance imaging (MRI)	not using ionizing radiation	high costs owing to scan acquisition and after processing of data
Ultrasonography (US)	simple, portable, safe, and noninvasive	more prone to technical errors

ionizing radiation. Therefore, it is safe across age ranges and groups and allows for serial assessments. However, the disadvantage of MRI is its high costs owing to scan acquisition and after processing of data.

e) Ultrasonography (US)

Ultrasonography (US) is commonly used for diagnosis and follow-up purposes in clinical settings because ultrasound scanning is a simple, portable, safe, and noninvasive technique. The use of US in body composition assessment is promising due to its ability to quantify tissue thickness and assess subcutaneous adipose tissue, followed by visceral adipose tissue. In addition, it has been reported that US has a high correlation with areas or volumes of fat detected by CT or MRI (16). On the other hand, the disadvantage of ultrasonography for body composition assessment is that it is prone to technical errors caused by muscle compressibility, selection of a reliable site, optimal transducer position management, ability to ensure a full relaxation or contraction state, and the patient's resting state and hydration status (17).

2) Laboratory parameters

a) Biochemical tests

Several biochemical tests, such as serum albumin, transthyretin (prealbumin), transferrin, retinol binding protein (RBP), total cholesterol, and cholinesterase, are used for nutritional screening and assessment. Serum proteins have different half-life times (Table 3). For instance, serum albumin is a good predictor for outcome and reflects disease severity. Serum albumin is also thought to be useful as a long-term nutritional control marker. To assess short-term changes, transthyretin, RBP, and transferrin are more useful. However, serum proteins have many limitations. The concentrations of visceral proteins decrease with overhydration and increase with dehydration, independent of nutritional status. In addition, serum levels of albumin and transthyretin are strongly affected by inflammation. Serum transferrin and RBP are also affected by various factors. Taken together, anthropometric measurements are most useful to assess nutritional status, and albumin and other visceral proteins should no longer be considered as nutritional markers, but rather as inflammatory response markers.

b) Nitrogen balance studies

Nitrogen balance studies calculated from urinary urea nitrogen are often used to assess protein catabolism (Figure 2). Nitrogen balance may be the only way to assess the responses to nutritional interventions. However, nitrogen balance studies are mainly research tools, because under clinical conditions, nitrogen intake is nearly always overestimated and nitrogen losses tend to be underestimated.

Nitrogen-balance

Nitorgen-balance (g/day) =
Protein-intake (g/day) / 6.25 – urinary urea nitrogen (g/day) × 1.25

Creatinine excretion rate (CHI)

CHI (%) =
measured 24h urinary creatinine ×100 / ideal 24h urinary creatinine for height*
(* obtained from standard values)

Energy expenditure

Energy expenditure (kcal/day) =
[3.94 × VO_2 (ml/min) + 1.10 × VCO_2 (ml/min)] × 1.44 – 2.17 × urinary urea nitrogen (g/day)

Respiratory quotient (RQ)

RQ = VCO_2 (ml/min) / × VO_2 (ml/min)

Figure 2 : Nutritional assessment tools
Nitrogen balance, creatinine excretion rate (CHI), energy expenditure, and respiratory quotient can be calculated by measurement data.

c) Creatinine excretion rate

Urinary creatinine excretion reflects muscle mass. Urinary creatinine excretion over 24 hours is used to calculate a creatinine height index (CHI) (Figure 2). A deficit of 5-15% is classified as mild malnutrition, 15-30% as moderate, and more than 30% as severe. However, the weak point of this method is that there is substantial individual variability in daily urinary excretion of creatinine.

Table 3 : the differences of serum proteins known as nutritional marker

	Albmin (Alb)	Transferrin (Tf)	Prealbumin (PA)	Retinol binding protein (RBP)
Role	• main protein of human blood plasma • Regulation of colloidal osmotic pressure	• participation in transportation of iron	• also known as transthyretin • transportation of thyroxine and retinol	• transportation of retinol
half-life time	21 days	7 days	2 days	0.5 days
reference value	3.9-4.9 g/dl	Male : 190-300 mg/dl Female : 200-340 mg/dl	Male : 23-42 mg/dl Female : 22-34 mg/dl	Male : 3.6-7.2 mg/dl Female : 2.2-5.3 mg/dl

3) Evaluation of immune competence

Total lymphocyte count (TLC), delayed cutaneous hypersensitivity, purified protein derivative of tuberculin, and serum levels of immunoglobulin are used for evaluation of immune competence. Among them, TLC is more useful in clinical practice. A total of 1500-1800 is classified as mild malnutrition, 900-1500 as moderate, and less than 900 as severe.

4) Functional tests

Functional tests, such as grip strength test, indirect calorimetry, and swallowing function evaluation, are also used for identification of malnutrition. Grip strength is closely related to sarcopenia and is recommended as a good simple measure of muscle strength.

In indirect calorimetry, energy expenditure is calculated from oxygen consumption and carbon dioxide production. The energy equivalent of oxygen consumption (VO_2) and carbon dioxide production (VCO_2) is dependent on the quantities of carbohydrates, proteins, and fats oxidized. Protein oxidation is calculated from nitrogen lost in urine. Energy expenditure and respiratory quotient (RQ) are calculated by the formula shown in Figure 2 (18).

Loss of swallowing function causes malnutrition and aspiration pneumonitis, because swallowing movement is related to obtainment of nourishment and to protection of the respiratory tract. Videofluorography and video endoscopic examination of swallowing are the gold standards in the evaluation of swallowing function.

3. FUTURE PROSPECTS OF ODA

One of the reasons why nutritional management was paid little attention in clinical practice is thought to be that there is no gold standard to assess nutritional status because there are few reliable parameters of nutritional assessment. In recent years, many kinds of ODA methods such as BIA, US, CT, and MRI have been developed and they are able to obtain precise results with less dispersion. In addition, several models have been developed for body composition analysis and widely known. In order to perform ideal nutritional management and therapy, it is necessary to observe the temporal changes of nutritional status. It is expected that recent ODA methods will cause better nutritional care.

CONCLUSION

Nutritional screening and assessment are fundamental factors in clinical practice. Sufficient understanding of SGA and ODA as nutritional screening and assessment tools is important for better nutritional management.

CONFLICT OF INTEREST

None declared

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