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Abstract

Methods and Interests of Bioelectric Impedance in Medical Practice †

Lotfi Rahal [1,2]

[1] Faculty of Medicine, Tahri Mohamed University, Bechar 08000, Algeria; dr.lotfirahal@univ-bechar.dz
[2] Department of Clinical Physiology and Functional Explorations, Bechar Public Hospital Establishment, Bechar 08000, Algeria

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The development of new tools of functional explorations in medicine revolutionized the means of the diagnosis of different pathologies and allowed a clear improvement of the patients' management. Bioelectric impedance (BI) is a body analysis method in full expansion that is nowadays applied in routine clinical practice by various medical specialties. The study of body composition by bioelectric impedance analysis (BIA) not only allows a better understanding of the pathophysiology of many diseases but also, in some cases, traces their evolution in order to guide treatments [1,2]. BIA is based on the generation of a continuous electric current of low intensity ($\leq$1 mA; 50 kHz) through two electrodes (outer electrodes) and the measurement of the voltage by two other electrodes (inner electrodes) fixed in the upper and the lower limb on the same side of the body [2]. Resistance (R) is calculated from the impedance (Z_B) expressed by different tissues, and the evaluation of the different parts of the body composition is based on predefined equations [2]. Usually, in clinical practice, simple measurements are used (body mass index: BMI; waist circumference: WC; hip circumference: HC; waist-to-hip ratio: WHR, etc.) to estimate the level of overweight; however, their limitations are important, hence the interest in using other more precise methods such as BI, which allows a more detailed analysis of the body composition by evaluating the proportion of fat mass (FM) and fat free mass (FFM) or lean mass, the total body water (TBW), the basal metabolic rates (BMR), and the estimated average (energy) requirement (EAR) [2]. Impedance corresponds the resistance offered by a tissue (biological conductor) relative to the passage of a low intensity alternating current; this impedance is a function of the body's water content as well as the frequency of the applied alternating current signal. In the human body, the FFM, due to electrolytes dissolved in water, is a good conductor of electricity compared to the FM, and the principle of BIA is therefore to measure the body's water and deduce the amount of FFM, assuming a constant hydration factor (usually 73%, hence the following: FFM = TBW/0.73) [3,4]. The FM is obtained in a second step by calculating the difference with the total body weight (considering the two-compartment model) [5]. The BIA also assessed skeletal muscle mass and appendicular muscle mass, which are the main parameters in the screening of sarcopenia. Moreover, the interpretation of the level of the body's hydration is based on the clinical context: states of intra- and extracellular hydration, the presence of a third sector in case of edemas, etc. [3]. Other parameters, such as the impedance ratio (impedance measurements at high and low frequencies: Z200/Z5) and phase angle (time measured in degrees when phase shift between current and voltage occurs), are also useful and practical tools in the monitoring and evaluation of performance in athletes and also for predicting the risk of 'mortality' in different pathologies, namely undernutrition and cancer [2,3]. By conducting this study, we will review the physical principles of bioelectric impedance as well as its applications and limitations in current medical practice.

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