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Appraisal

Clinimetrics: Bioelectrical Impedance Analysis in Clinical Practice

Summary

Description: Body mass index (BMI) is commonly used as a measure of health status. However, research indicates that BMI, which fails to differentiate between individual body compartments, has significant limitations for diagnosing clinical conditions (eg, malnutrition and sarcopenia), evaluating therapeutic interventions (eg, diet and exercise) and predicting health outcomes.[1] This highlights the importance of body composition techniques that can easily be applied in clinical practice.

Bioelectrical impedance analysis (BIA) is of particular interest as it provides a portable, low-cost, quick, safe and non-invasive method with which to measure muscle mass at the bedside.[2] Acceptance of BIA in clinical practice is reflected by international nutrition guidelines recommending BIA to identify muscle depletion when diagnosing malnutrition.[3] Additionally, updated guidelines emphasise the need to combine both muscle strength and muscle mass measurements (with BIA being an accepted method with which to identify muscle depletion) when diagnosing sarcopenia.[4] BIA measures the opposition to an alternating current through body compartments (resistance) and the delay in conduction by cell membranes (reactance) via the application of electrodes attached to, or in contact with, the hands and feet of the subject. The drop in voltage as the current passes through the body (the impedance) is detected via electrodes and the device records raw impedance data (resistance, reactance and phase angle).[5] Raw impedance data are combined with variables such as age, weight, height and gender into population-specific equations to generate an estimate of total body water, and from this fat mass and fat-free mass are estimated.[6]

There are different types of BIA, including single frequency, multifrequency and bioimpedance spectroscopy.[2] Clinicians using the technique need to understand the underlying theory and limitations of each of these methods; an in-depth discussion can be found elsewhere.[2]

Clinimetric properties: BIA has excellent inter-rater and intra-rater reliability for repeated measurements;[2] however, this method relies on multiple assumptions for fat mass and fat-free mass estimations, and violation of these underlying assumptions at an individual level can compromise accuracy.[7] Specifically, this methodology assumes a constant distribution between intracellular and extracellular water, stable hydration of fat-free mass at 73% and predictable body geometry.[2,7] Violation of these assumptions raises potential for error in individuals who differ from normal weight, shape and density, including the obese and clinical populations where significant fluid shifts are common (eg, critical illness, renal and liver failure). Moreover, the commonly used fat-free mass cut-points to identify individuals with muscle depletion (and recommended in clinical guidelines) are derived from a healthy Caucasian population and require further evaluation to determine their applicability in specific clinical and other populations.[3]

Due to the limitations of using BIA to estimate body compartments in the clinical setting, there is increasing interest in the raw BIA variable: phase angle. Phase angle is directly measured from the arctangent of the ratio of reactance to resistance (most commonly at 50 kHz) and is thought to reflect cellular health and body cell mass.[5,8] Several studies have identified phase angle as a potential prognostic indicator for clinical outcomes, including increased postoperative length of stay and mortality in a range of clinical populations.[5,8,9]

Multiple factors during test preparation can introduce error in the interpretation of results, including: patients not being in a fasted state, inadequate limb separation, fluid and electrolyte shifts, fevers causing skin temperature elevations, impaired skin integrity interfering with electrode placement, and the presence of medical devices interfering with the bioimpedance device.[2]

Commentary

Although BIA shows potential for body composition assessment and prognostication in clinical environments, clinicians must consider the limitations with the BIA device they are using and the population they are using it with. The same device should be used for repeated measures. Clinicians need to be aware of factors that introduce error, the need for adequate training and for standardised protocols, which can mitigate many of these issues. Overall, BIA provides a simple, cheap and non-invasive method with which to measure body composition and cellular health at the bedside. The data in combination with other clinical information can be utilised to assess the risk of disease, diagnose clinical conditions and/or evaluate the response to interventions in a range of clinical populations.

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