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ORIGINAL ARTICLE

Validity of impedance-based equations for the prediction of total body water as measured by deuterium dilution in Cameroonian HIV-infected patients treated with antiretroviral treatment

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Received 26 February 2008; accepted 10 July 2008

KEYWORDS

Bioelectrical impedance analysis; BIA equation; Total body water; Deuterium dilution; African HIV-infected patients; Antiretroviral treatment

Summary

Background & aims: No information is available on the validity of impedance-based equations for the prediction of body composition in Cameroonian HIV-infected patients treated with antiretroviral drugs. Equations for the prediction of total body water (TBW) have the tendency to be population-specific, and this may be due to biological factors, such as variable body geometry and physiological state. We tested the validity of equations derived from different racial backgrounds for predicting TBW from bioelectrical impedance analysis measurements.

Method: The TBW content of 56 Cameroonian HIV patients (19 men and 37 women) treated with the first-line ARV regimen was measured by deuterium dilution and compared with those predicted by 12 equations developed respectively in samples of white, black, black and white, or unspecified racial background subjects.

Results: Pure errors in predicting TBW showed acceptable value for all the equations tested. Four equations (three from whites and one from blacks and whites) yielded a non-significant bias; however, equation *H* which presented the narrower 95% confidence interval and the smaller pure error was recommended for the prediction of TBW in Cameroonian HIV-infected patients treated with antiretroviral drugs. In all other cases, we observed either an overestimation or underestimation of TBW with variable bias values.

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Conclusion: The absence of a clear trend in cross-validation among equations according to their origin and the probable effect of physiological state should encourage further exploration of the causes of the lack of validity.

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Introduction

At the end of 2005, about 505,000 persons were living with HIV in Cameroon, and nearly 58,000 had become newly infected with HIV during the same year. Though only 18% of the Cameroonians who needed HIV therapy were receiving HIV medications, free access to HIV medications in the country since May 2007 has gradually increased the number of patients treated with antiretroviral drugs. The transition to greater access to HIV medications will shift the research priorities related to nutrition in HIV-infected persons. Nutritional benefits of antiretroviral treatment have now been clearly observed^{1,2} although there are some concerns regarding metabolic dysfunction with protease inhibitor drugs. However, most existing recommendations on antiretroviral drugs are based on research with well nourished, relatively food secure population groups. The dietary implications for individuals suffering from pre-existing protein energy malnutrition and micronutrient deficiencies may be different, such as in resource limited settings. This implies the necessity of a systematic evaluation of the nutritional status of HIV-infected patients treated with antiretroviral drugs, for proper nutritional care and support.

Assessment of body water is of great diagnostic value, and it is frequently measured to evaluate body composition, a sensitive indicator of health and nutritional status. Body water volumes change with a person's nutritional status. In healthy subjects, the hydration of fat-free mass and the ratio between extracellular (ECW) and total body water (TBW) are tightly regulated. In malnourished subjects and under a variety of other disease conditions there is usually a relative increase in ECW, which often results in an increase of TBW.³

Deuterium oxide dilution technique is the most accurate method for measuring TBW, but it is expensive, not widely available and thus difficult to apply to many subjects. Therefore, cheap and simple methods are needed for routine clinical and epidemiological field studies, notably in low-income countries; for this purpose, bioelectric impedance analysis (BIA) has attracted much interest as an inexpensive, simple to use, and portable technique.^{4–6} However, BIA measurement is an indirect method from which body composition is predicted. Although improvement in the predictions of body water by BIA has been demonstrated in studies in experimental animals,⁷ prediction studies in humans have shown only marginal⁸ or no improvement using modeling procedures.^{9–11} Prediction equations for body composition have the tendency to be population-specific, and this may be due to biological factors, such as variable body geometry and physiological state.¹²

Since the validity of BIA prediction equations in patient populations, such as African adults treated with

antiretroviral drugs, has yet to be demonstrated, the aim of the current study was to compare the results of the deuterium dilution technique with those of the more convenient multifrequency BIA method during antiretroviral therapy. In this study, TBW was estimated using Bodystat[®] equation and 11 equations developed by Kushner and Schoeller,¹³ Zillikens and Conway,¹⁴ Leman et al.,¹⁵ Deurenberg et al.,¹⁶ Van Loan and Mayclin,¹⁷ Sun et al.,¹⁸ and Schoeller and Luke,¹⁹ which are based on measurements in apparently healthy subjects.

Materials and methods

Subjects

Fifty-six patients, men ($n = 19$) and women ($n = 37$), between 19 and 62 years of age, were selected from the outpatient clinic of the Yaounde Central Hospital among the 132 HIV-infected patients treated with the first-line ARV regimen (two nucleoside reverse transcriptase inhibitors and one non-nucleoside reverse transcriptase inhibitor) for a two month period, in accordance with the Helsinki Declaration. The ethics committee of Cameroon approved this study. All subjects gave their written consent to participate in the study after being thoroughly informed of its purpose, requirements, and procedure. All measurements were performed in the morning between 9 am and 1 pm, with a room temperature of 23 ± 5 °C. Subjects abstained from food and drinks for at least 6 h, did not perform strenuous exercise, and emptied their bladders preceding the measurements. Just after the BIA and anthropometric measurements were performed, deuterium water was administered orally to each subject, thus allowing the BIA and reference tests to be done at the same time and under similar conditions. Consequently, the hydration status was likely to have remained throughout the measurement period. Transaminases (SGOT and SGPT) and glycaemia were determined by a spectrophotometric method using Human kits. CD4 numeration was determined by cytometry flux using a FACSCount instrument (Becton Dickinson, USA). Haemoglobin, leucocytes, thrombocyte and red blood corpuscles counts were determined by electronic counting using a Hycel hematologic counter (Ref 575CA40).

Anthropometric measures

Measurements were made by trained personnel using standard procedures.²⁰ Wearing minimal clothes, the subjects were weighed to the nearest 0.01 kg with an electronic scale (Seca, Hamburg, Germany). Height was measured to the nearest millimeter with a portable gauge

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