ESTIMATION OF BODY COMPOSITION BY BIOELECTRICAL IMPEDANCE ANALYSIS (MFBIA): THE EFFECTS OF BODY ELECTROLYTE STATUS

A. REES and L. WARD

Multiple frequency bioelectrical impedance analysis (MFBIA) is a simple non-invasive technique that has found extensive application in nutrition for the assessment of body composition in man and animals (Jebb and Elia 1993). The principle underlying MFBIA is that the impedance, that is the opposition to flow of an ac electrical current through the body is inversely proportional to the water content in a frequency-dependent manner. Impedance at low frequencies correlates with extracellular water (ECW) whilst at high frequencies impedance correlates with total body water (TBW) (Thomas et al. 1992). The measured impedance is, however, not only related to the volume of the conductor, ie body water, but also to its inherent conductivity (or resistivity). The primary determinant of the conductivity of biological fluids is the concentration of ions. Thus in those physiological states in which ion status is abnormal, predictions of body fluid volumes, based upon impedance measures, will be in error. The aim of this study was to investigate the effects of bodily ion status upon bioelectrical impedance in a rat model.

Rats, weighing approximately 200 g, were infused, via a lateral tail vein, with saline solutions ranging in concentration from 0.5 M to 2.5 M over a 30 min period. The infusion rate was 0.023 ml/min. Control animals were either infused with water or sham-infused. Whole body bioelectrical impedance was determined at 2 min intervals throughout the infusion according to the protocol of Cornish et al. (1992). Blood samples were obtained prior to and following the infusion for the determination of blood concentrations of K+, Na+, Cl^- urea and glucose. Independent measures of body fluid volumes were determined by multiple indicator dilution techniques (^3H_2O for TBW; NaBr for ECW; Evans Blue Dye for plasma volume). Impedance data were analysed according to the procedure of Comisil et al. (1992) to provide estimates of intracellular resistance (R_i), extracellular resistance (R_e) and impedance at the characteristic frequency (Z_c), predictive of ICW, ECW and TBW respectively.

The results showed that R_i was not changed significantly during any infusion regimen whilst both R_e and Z_c decreased in proportion to the amount of NaCl infused. Infusion of saline (2.5 M) elicited an approximately 30 mM increase in plasma [Na] although TBW was essentially unchanged by infusion of a total of only 0.69 ml. Thus the observed changes in bioimpedance may be attributed primarily to change in resistivity due to alterations in ion concentration rather than fluid volume.

These data clearly demonstrate that MFBIA is influenced by the ion status of the body. Consequent to this, the assumption of constant tissue resistivity underlying the theoretical basis for MFBIA may not be correct in all circumstances. Thus caution should be exercised in interpretation of body composition data determined by MFBIA in subjects who may have altered electrolyte status.

CORNISH, B.H., WARD, L.C. and THOMAS, B.J. (1992). Nutr. Res. 12: 657.
JEBB, S.A. and ELIA, M. (1993). Int. J. Obes. 17: 611.
THOMAS, B.J., CORNISH, B.H. and WARD, L.C. (1992). J. Clin. Eng. 17: 505.

Department of Biochemistry, University of Queensland, Brisbane, Queensland 4072