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A Novel Approach to Classify Risk in Dengue Hemorrhagic Fever (DHF) Using Bioelectrical Impedance Analysis (BIA)

Fatimah Ibrahim, Mohd Nasir Taib, *Senior Member, IEEE*, Wan Abu Bakar Wan Abas, Chan Chong Guan, and Saadiah Sulaiman

INTRODUCTION

IN RECENT years, bioelectrical impedance analysis (BIA) has become an increasingly popular modality in the assessment of human body composition: bioelectrical tissue conductivity, mass distribution and water compartments. BIA technique, which measures the whole body bioimpedance, provides a noninvasive and practical method to estimate body composition and body hydration in human [1]–[6]. Since then, this technique is widely used in human nutrition and clinical research.

BIA has shown to be sensitive in determining the hydrational profile in dengue patients [7]–[9]. However, BIA did not improve on serial hematocrit and bodyweight determinations for monitoring plasma volume contraction and extracellular expansion in dengue patients, respectively [10]. Recent studies on BIA indicate body composition, as reflected by reactance, greatly influence the assessment of hematocrit status and modeling of hemoglobin in dengue hemorrhagic fever [11], [12].

Dengue fever (DF) is an acute febrile viral disease frequently presented with headache, bone or joint and muscular pains, and rash. A significant percentage of DF patients develop a more severe form of disease, known as dengue hemorrhagic fever (DHF). DHF is an infection associated with an increase in microvascular permeability, a decrease in plasma volume, and in severe forms hypotension and shock [13]. Measurement of total increase in hematocrit (Hct) (over 20%) or hemoglobin (Hb) concentration (Hb above the upper normal range limit) is one of the method for monitoring the onset and progression of plasma leakage [13]. Another conventional method for monitoring risk in DHF patients is to monitor their platelet count and liver function status [13], [14]. These techniques are invasive, tedious, and time-consuming. Moreover, frequent blood taking will cause further injury to the subcutaneous tissue and potentially risky to the DHF patients.

This paper describes a novel noninvasive approach to monitor and classify the daily risk in patients suffering from DHF by using bioelectrical impedance (single frequency) technique. We investigated the prognostic relevance of bioelectrical tissue conductivity (BETC), capacitive reactance , resistance ( ), phase angle , and body capacitance ( ) in BIA, to be the independent variables to classify the risk severity of DHF patients. The experimental results illustrate the reactance pattern where female DHF patients are more sensitive and risky than the male DHF patients. Any change in the value of reactance will indicate the changes in electrical conductivity of the body, and this can be used to classify the risk severity.

BIA Technique

BIA is a technique to estimate body composition and is an assessment of changes in a human’s BETC as reflected by , , and other factors for an indication of any alteration in the body composition. BIA measures the impedance through the body fluids contained mainly in the lean and fat tissues. The impedance is low in the lean tissue, which consists of intracellular fluid and electrolytes; however, it is high in fat tissue.

A. Experimental Assumptions and Conditions

The impedance of biological tissue comprises two components, the resistance ( ) and the capacitive reactance . In the body, a highly conductive lean tissue contains large amounts of water and conducting electrolytes and represents a low-resistance electrical pathway. On the other hand, fat and bone with low amounts of fluid and conducting electrolytes are poor conductors, and they have high electrical resistance. Capacitive reactance is the capacitance produced by tissue interface and cell membrane. It is an indirect measure of the intracellular volume.[1] Phase angle is defined as in (1).

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