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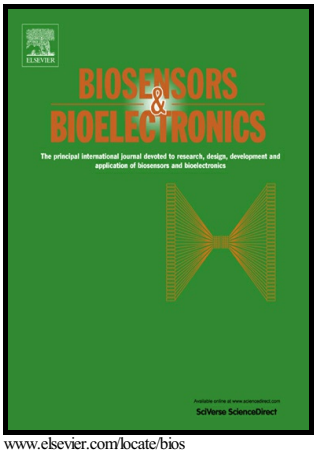

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Red Blood Cells Aggregability Measurement of Coagulating Blood in Extracorporeal Circulation System with Multiple-frequency Electrical Impedance Spectroscopy

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ABSTRACT: Red blood cells (RBCs) aggregability A_G of coagulating blood in extracorporeal circulation system has been investigated under the condition of pulsatile flow. Relaxation frequency f_c from the multiple-frequency electrical impedance spectroscopy is utilized to obtain RBCs aggregability A_G. Compared with other methods, the proposed multiple-frequency electrical impedance method is much easier to obtain non-invasive measurement with high speed and good penetrability performance in biology tissues. Experimental results show that, RBCs aggregability A_G in coagulating blood falls down with the thrombus formation while that in non-coagulation blood almost keeps the same value, which has a great agreement with the activated clotting time (ACT) fibrinogen concertation (F_{bg}) tests. Modified Hanai formula is proposed to quantitatively analyze the influence of RBCs aggregation on multiple-frequency electrical impedance measurement. The reduction of RBCs aggregability A_G is associated with blood coagulation reaction, which indicates the feasibility of the high speed, compact and cheap on-line thrombus measurement biosensors in extracorporeal circulation systems.

Keywords: Blood, red blood cell aggregability, dielectric relaxation frequency, electrical impedance spectroscopy, electrical sensor

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1. Introduction

Blood extracorporeal circulation systems, such as artificial ventricular assistance devices (VAD), extracorporeal membrane oxygenation (ECMO) and heart-lung machines, have been widely used in clinical treatments for the patients with cardiovascular diseases (Jhun et al, 2014). However, the utilization of artificial pumps and tubes causes thrombus formation, which remains a major danger for these patients (Starling, et al, 2014). Anticoagulation treatment is quite often utilized for these patients with blood extracorporeal circulation systems to prevent the threat of thrombus formation. Nevertheless, excessive or insufficient anticoagulation will bring fatal bleeding or infraction (O'Brien et al, 1997),

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