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Design and evaluation of an electrochemical immunosensor for measles serodiagnosis using measles-specific Immunoglobulin G antibodies

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ABSTRACT

The design of electrochemical immunosensors for the detection of measles-specific antibodies is reported. The measles-antigen modified surface was used as an antibody capture surface. The detection of measles-specific IgG antibodies was accomplished using the voltammetric method and horse-radish peroxidase (HRP) labeled secondary antibody (anti-IgG) as a detecting antibody. The potential applications of the designed immunosensor were evaluated in buffer and serum solutions. The immunosensor exhibited good linearity at concentrations less than 100 ng mL^{-1} with R^2=0.997 and the limit of detection of 6.60 ng mL^{-1} at 3σ. The potential application of the immunosensor was evaluated in the deliberately infected human and newborn calf serum samples with measles-IgG antibody mimicking real-life samples. The designed electrochemical immunosensor could differentiate between infected and un-infected serum samples as higher catalytic currents were obtained for infected serum samples.

1. Introduction

Measles virus (MV) is a single-strand ribonucleic acid virus belonging to *Morbillivirus* genus in the family of Paramyxoviridae. MV is highly infectious and deadly to children with adult infection rate relatively small compared to children. MV can be transmitted through large droplets from coughing and sneezing or direct contact with the nasal or throat secretions from an infected person [1]. Secondary infections by MV do occur and this makes the detection and monitoring of this virus very important. Eastern and southern African countries have recently reported the resurgence of measles outbreaks with 200,000 confirmed cases and 1400 recorded deaths according UNICEF/WHO [2,3] and Centers for Disease Control and Prevention [4]. Confirmed measles cases have also been reported in various countries and regions worldwide making this a global problem [5–10]. South Africa has recently experienced various disease outbreaks, such as rift-valley fever (a zoonotic disease) with 13,902 confirmed animal cases (8581 deaths) [11] and measles with >17,000 confirmed human infected cases [11–13]. The complications of measles-HIV co-infections were reported during the outbreak [13]. The treatment of measles on HIV infected individuals is slower due to compromised immune response and hence slow production of measles-specific antibodies. The slow production of measles-antibodies results in slowing measles treatment and the recuperating process [14–16]. However there are no adverse effects to measles vaccination or treatment in HIV-infected individuals [17,18].

Serological testing methods for measles diagnosis monitor the production of Immunoglobulin M (IgM) [19–23], Immunoglobulin G (IgG) [19–21,24,25] and the presence of measles virus [23,26]. Commercially available systems widely used for measles serodiagnosis are based either on enzyme immunoassays (EIAs) or polymerase chain reactions (PCRs). Enzyme-linked immuno-sorbent assays (ELISAs) are the preferred system. IgM antibodies are the first antibodies produced in early stages of measles virus infection and disappear after almost 5 weeks. Therefore, they have been accepted as markers for recent or acute measles virus infections. On the other hand, IgG antibodies are the secondary produced antibodies and are known to persist long after the infection or immunization [21]. When IgG is used for serodiagnosis of measles, an increase in IgG antibody titer indicates an acute measles infection whilst stable levels of IgG antibody indicates convalescent stage of measles infection [27,28]. To evaluate whether the antibody titer are increasing, decreasing or remaining the same,

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