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Electrochemical impedimetric immunosensor for the detection of measles-specific IgG antibodies after measles infections

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ABSTRACT

The detection of measles-specific primary antibodies (IgG) using electrochemical impedimetric immunosensors is reported. The optimum conditions for electrode saturation were reached after 40 min for 1 μg ml^{-1} antibody concentrations. Surface roughness using AFM increased with each immobilization or antigen-antibody reaction step clearly confirming the surface modification and recognition between antigen and antibody. The human serum (HS) and new-born calf serum (NCS) spiked with antigen-specific antibody were studied to mimic the real sample analysis. The HS and NCS sera containing antibodies due to measles exhibited correlation between the increasing antibody serum concentrations and the charge-transfer resistance (electrochemically measured). This work clearly showed the potential use of impedance as the preferred electrochemical method for detecting measles-antibodies in label-free manner.

1. Introduction

The world in the recent past has experienced an increase in viruses or diseases outbreaks, especially communicable and infectious viruses such as a pandemic of H1N1 and measles in Eastern and Southern Africa region (WHO/UNICEF, 2010; WHO, 2011). Measles cases have also been reported in various countries and regions worldwide making this a global problem (Brown et al., 2011; Ramamurty et al., 2006; Kuroiwa et al., 2001; Vainio et al., 2011; Vyse et al., 2002; Ehresmann et al., 2004). The virus outbreaks have been met with the lack of on-site analytical tools for their detection and hence preventing their spread. Therefore, there is an increasing demand for analytical devices for early detection and surveillance of disease or virus outbreaks. South Africa has in the recent past experienced various disease outbreaks, for an example zoonotic rift-valley fever with 13,902 confirmed cases (8581 deaths) (NICD, 2011), measles with $>$17,000 confirmed cases (Albertyn et al., 2011; le Roux et al., 2012; NICD, 2011). Measles virus (MV) is highly infectious and deadly in children with adult infection rate relatively small compared to children. MV spreads easily amongst people and can be transmitted through large saliva droplets from coughing and sneezing or direct contact with the nasal or throat secretions from an infected person (WHO, 2007). Early diagnosis of measles using sensitive and specific systems is of paramount importance for administering effective treatment. Measles is studied here because of its resurgence in Eastern and Southern African region which highlighted the lack of diagnosis systems, hence their spread. There is therefore a high demand to develop new analytical systems that offer same sensitivity and specificity as the laboratory based enzyme immunoassays (EIA) used for measles serodiagnosis (Erdman et al., 1991; Hummel et al., 1992; Riddell et al., 2003; Isa et al., 2001) that offer ease of analysis and minimize the analysis time. The new analytical systems should (i) allow for applications in remote locations sometimes without electricity and (ii) be easy to use with ease of data interpretation and analysis. These requirements are well fitting and have resulted in an increase use of rapid lateral flow point-of-care (POC) tests or dip-sticks (Kumamoto et al., 2010; Hosegawa et al., 2009; Warrener et al., 2011). POC and dip-sticks are only used for qualitative analysis and give result of whether or not the sample is infected and this is their limitation if quantitative results are required. Quantitative results give more details such as the extent of the sickness and/or the amount of the analyte detected. For measles serodiagnosis using IgG antibodies, the requirement for the systems is that it should be able to tell whether the measles infection is acute or convalescent. The differentiation can be obtained by measuring two samples from a suspected individual and the samples should be obtained two weeks apart. The increase in antibody titer confirms acute measles infection and decrease

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