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Genosensors Could Save Meningitis Patients

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ABSTRACT

Background*:* Meningitis considered as one of the life-threatening diseases in humans which mainly caused by *Neisseria meningitides*. The onset of this bacterium can occur rapidly, and the disease progresses are quickly. Also, clinical symptoms of this disease emerge relatively late. For these reason, detection of this infection is difficult. This report explores using genosensors as a novel solution for the rapid diagnosis and detection of *Neisseria meningitides*.

Conclusion: Newly, for bacterial detection genosensors has been designed and used for diagnosis of some disease. Due to their simplicity, specificity, sensitivity, easy and convenient way to use, high accuracy, low detection time, use on site, and low cost it has been converted to a suitable way for rapid and accurate detection method for bacterial infection.

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Introduction

Meningitis is a dangerous and life-threatening disease caused mainly by *Neisseria meningitides* (*N. meningitidis*) which can be result in high rate of morbidity and mortality. Routine methods of detection of this bacterium have some limitations (1). The onset of this life-threatening infection is rapid, clinical symptoms emerge late, and usually there is no enough time for diagnosing.

It should be noted that, in clinical diagnosis, detection and identification of bacterial species are one of the most important challenges (2). Since meningitis infections has high rate of severity and mortality, a rapid diagnosis of etiology of the disease is critical. *Neisseria* isolation from clinical samples is difficult as a microaerophilic condition with specific temperature is required. Detection of *Neisseria* in CSF is time-consuming and usually take 2-3 days. The meningitis can be diagnosed by X-ray and CT scanning, PCR, immunological test, analysis of CSF, latex agglutination test, Gram staining, and biochemical test. These tests are time-consuming, expensive and non-confirmatory. Recently, genosensors or nucleic acid based biosensors have been used instead of traditional detection methods as they are more sensitive, faster, simpler and economical (3).

Genosensores are well suited for the detection of bacterial infection especially bacteria that need to be diagnosed immediately and as soon as possible so that the correct antibiotic treatment can be started and the patient's life can be saved. Genosensores are sensitive, selective, and its simplicity, availability, suitability for decentralized applications, feasibility for miniaturization has been converted them as a useful tool.

Since, electrochemical genosensors have a range of distinct chemistries, they have nanoscale interactions between the recognition layer, target molecules which are present in solution, and the designed electrode surface (4, 5). Due to the rapid diagnosis of genosensors, the importance of this strategy in detecting of this bacterium is evident.

In a study, the Omp85 genosensor can detect as little as 6 ng ssG-DNA in 6 microliter CSF of a human brain meningitis patient in 30 min including a response time of 1 min (6). In another study, rmpM gene-based sensor can detect 3 ng/6 µL ssG-DNA of *N. meningitidis* directly from CSF of the patient in 30 min without culturing and isolating GDNA. The sensitivity of the genosensor is 9.5087(µA/cm2)/ng with R2 as 0.9874. The rmpM genosensor is highly specific to *N. meningitidis* and can be used for quick detection of bacterial meningitis during an outbreak by using SPGE array to save the life of several patients (1). Also there are some other genosensors with different target genes in this subject (3, 7-9).

Conclusion

Genosensors represent a powerful and innovative diagnostic platform capable of overcoming the major limitations of conventional methods used for detecting *N. meningitidis*, the primary causative agent of bacterial meningitis. Given the rapid onset, high mortality rate, and diagnostic challenges associated with this infection, the high sensitivity, specificity, speed, portability, and low cost of genosensor-based assays make them an ideal alternative for timely identification of the pathogen. Evidence from multiple studies shows that gene-targeted electrochemical genosensors including those based on Omp85, rmpM, and CtrA can detect minute quantities of bacterial DNA directly from CSF samples within minutes, without the need for culture. These findings highlight the significant potential of genosensors as life-saving diagnostic tools, particularly in emergency settings and outbreak scenarios, where rapid detection is critical for initiating appropriate treatment and improving patient survival.

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Ethics approval and consent to participate

This article does not contain any studies with animals performed by any of the authors.

Conflict of interest

The authors declare that they have no conflict of interest.

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