Title: Nanomaterial Enhances the Performance of Amyloid-beta Biosensing for Alzheimer's Disease Diagnosis

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Abstract: Background: Highly sensitive, accurate, and low-cost detection systems are gaining interest for early intervention in the progression of Alzheimer's disease (AD). Amyloid-beta (Aβ), a peptide highly involved in the progression of AD, is found in abundance in patients with severe AD.

Objective: This research focused on developing an Aβ oligomer (AβO) biosensor using a single-walled carbon nanotube-modified (SWCN) interdigitated electrode (IDE) sensor.

Methods: The SWCN was functionalized onto the sensor surface through an amine linker, followed by the attachment of an aptamer-gold nanoparticle (GNP) complex, which was used to capture the AβO.

Results: The GNP-aptamer was saturated at 500 nM on the SWCN surface, and AβO was detected using a sandwich consisting of aptamer-AβO-antibody. The SWCN modification increased the number of aptamer attachment sites on the IDE, while the aptamer and antibody conjugation with GNP enhanced AβO interaction. This sandwich assay detected AβO at concentrations as low as 10 fM, with a linear regression coefficient ($y = 2.9189x - 2.076$; $R^2 = 0.9544$). Furthermore, AβO-spiked artificial CSF was detected without interference, as confirmed by the increased current responses. No significant changes were recorded with control proteins, including α-synuclein, IgG antibody, and a complementary aptamer, indicating specific AβO detection.

Keywords: Alzheimer’s disease; IgG antibody.; amyloid-beta; biosensor; interdigitated electrode; nanomaterial.

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