

From Bench to Bedside: Electrochemical Biosensors for Rapid Alzheimer's Disease Screening

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Alzheimer's disease (AD), the leading cause of dementia in aging populations, arises from amyloid- β deposition and tau hyperphosphorylation that progressively impair synaptic function. Given its decades-long preclinical phase, early biomarker-based detection is essential. Blood-based markers—the $A\beta_{42}/A\beta_{40}$ ratio, phosphorylated tau (p-tau217, pTau181), and glial fibrillary acidic protein (GFAP)—capture complementary facets of amyloid, tau, and neuroinflammatory pathology, and combining them consistently outperforms single-marker assays [1]. However, current platforms remain limited by low throughput, instability, and demanding sample preparation that hinder point-of-care translation [2].

We developed two electrochemical biosensors bridging bench and bedside to analyze blood from stroke patients—a high-risk population in which cerebrovascular injury and AD pathology interact bidirectionally, complicating differentiation between vascular and neurodegenerative cognitive decline. First, a dual-biomarker immunosensor using gold nanoparticle-modified screen-printed electrodes detects GFAP and pTau181 from 5 μ L of plasma within 30 minutes (LODs: 9.95 and 0.044 pg/mL). In 54 stroke patients and 20 controls, their combination achieved an AUC of 0.93. Second, an eight-channel electric double-layer field-effect transistor platform measures p-tau217 and $A\beta_{42}/A\beta_{40}$ in plasma and whole blood, with tannic acid-based immobilization enabling 10-day chip stability; combined plasma biomarkers achieved an AUC of 0.938, while whole-blood testing offered a practical, minimally processed alternative. Together, these platforms translate multiplexed AD biomarker profiling into rapid, cost-effective, point-of-care tools for early screening and risk stratification.

Keywords: Alzheimer's Disease, electrochemical platform, $A\beta_{42}/A\beta_{40}$ ratio, pTau181, pTau217, GFAP

References

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