A Colorimetric Lateral Flow Assay to Detect Neurodegeneration From Tears, Phase II

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Neurodegenerative diseases like Alzheimer's affect millions worldwide, yet current diagnostic methods remain invasive, expensive, and largely inaccessible during the critical early intervention window. Building on a phase I project, this study developed a two-component screening prototype: a colorimetric lateral flow assay (LFA) using a hydrogel molecularly imprinted polymer (MIP) synthesized via aqueous bulk polymerization with acrylamide, methacrylic acid, and MBAA as a crosslinker to selectively capture lysozyme-C, a protein consistently downregulated in the tear fluid of Alzheimer's patients. The hydrogel MIP was then incorporated onto a nitrocellulose membrane to create an LFA that determines protein concentration using a Bicinchoninic Acid assay and ImageJ analysis for integrated density values. Additionally, an online cognitive screening tool was built using a logistic regression model trained on a simulated dataset based on literature reviews incorporating demographic risk factors, tear production rate, standardized cognitive task scores, and assay output. After iterative optimization, the hydrogel MIP for lysozyme achieved an imprinting factor of 1.37, and the LFA incorporating the MIP demonstrated selective binding of lysozyme-C across a range of concentrations relevant to tear fluid, with a clear distinction between patients with cognitive decline and healthy controls. Finally, the model produced a composite risk score from input values in a web-based app using logistic regression. Together, these prototypes are a proof-of-concept for a non-invasive, predictive screening system using a multi-biomarker LFA and online cognitive testing, projected to cost less than $15 and capable of administration without specialized equipment or clinical infrastructure.

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