Chapter 12
Unveiling Alzheimer's: Exploring Biomarkers for Diagnosis and Progression

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ABSTRACT

In the intricate labyrinth of Alzheimer's disease (AD), biomarkers emerge as guiding stars, illuminating the path toward understanding and combating this formidable foe of cognition. This paper embarks on a voyage through the realms of biomarker research, navigating the intricate landscape of AD diagnosis and progression. From the celestial realms of imaging markers to the molecular depths of biochemical signatures, we delve into the essence of AD pathology. Like skilled cartographers, we map the terrain of early detection, shedding light on the subtle nuances that herald the onset of cognitive decline. As vigilant sentinels, we stand watch over disease progression, discerning the shifting tides of neurodegeneration. Through the kalei-

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doscope of current research, this paper crafts a mosaic of knowledge, unveiling the potential of biomarkers to guide clinical practice and illuminate the path toward therapeutic horizons in the realm of Alzheimer's.

INTRODUCTION

Alzheimer's disease (AD) stands as a formidable challenge to modern medicine, a relentless foe whose prevalence burgeons alongside aging populations worldwide. With an estimated 50 million people currently afflicted globally, projections suggest a doubling of this figure every 20 years, rendering AD an increasingly urgent public health concern (Alatrany et al., 2024). Characterized by insidious cognitive decline, AD exacts a profound toll on individuals, families, and societies, reshaping the landscape of healthcare delivery and resource allocation (Hazarika et al., 2024). Amidst this daunting clinical panorama, the quest for effective diagnostic tools, prognostic indicators, and therapeutic interventions assumes paramount importance (Rani et al., 2024). At the heart of this endeavor lies the realm of biomarker research, a frontier brimming with promise and potential (Shaffi et al., 2024).

Biomarkers, defined as measurable indicators of biological processes or responses to therapeutic interventions, serve as windows into the intricate mechanisms underlying disease pathology and progression (Alatrany et al., 2024). In the context of AD, biomarkers encompass a diverse array of modalities, ranging from structural and functional neuroimaging to biochemical assays of cerebrospinal fluid (CSF) and blood constituents (Hazarika et al., 2024). These biomarkers offer invaluable insights into the molecular underpinnings of AD, shedding light on the aberrant accumulation of amyloid-beta (Aβ) plaques and tau tangles, synaptic dysfunction, and neuronal loss that hallmark the disease (Rani et al., 2024). The significance of biomarkers in AD extends far beyond their diagnostic utility, encompassing their pivotal role in elucidating disease pathogenesis, facilitating early detection, and monitoring disease progression (Shaffi et al., 2024).

As such, biomarkers hold immense promise as tools for prognostication and patient stratification in both clinical trials and routine clinical practice. By enabling the identification of individuals at high risk of developing AD or those likely to experience rapid disease progression, biomarkers pave the way for targeted interventions aimed at delaying symptom onset or attenuating disease severity (Alatrany et al., 2024; Rani et al., 2024).