# Neurophysiological biomarkers in neurodegenerative diseases: From discovery to clinical application.

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## Introduction

Neurodegenerative diseases, including Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis (ALS), pose significant challenges in both diagnosis and management. The complexity of these conditions, characterized by progressive neuronal loss and functional decline, necessitates the identification of reliable biomarkers for early diagnosis, disease monitoring, and treatment evaluation. Neurophysiological biomarkers have emerged as crucial tools in this quest, offering insights into the underlying pathophysiology of these disorders and facilitating the development of targeted therapies [1].

Neurophysiological biomarkers are measurable indicators of neural function or dysfunction, derived from techniques that assess electrical activity, neural connectivity, and brain structure. These biomarkers are valuable in neurodegenerative diseases as they provide objective, quantifiable data that can complement clinical assessments and imaging findings. The integration of neurophysiological biomarkers into clinical practice holds promise for enhancing diagnostic accuracy and monitoring disease progression [2].

Electroencephalography (EEG) measures the brain's electrical activity through electrodes placed on the scalp. In neurodegenerative diseases, EEG can reveal characteristic patterns of neural disruption. For instance, in Alzheimer's disease, EEG abnormalities such as reduced alpha band power and increased theta and delta activity are observed. These changes correlate with cognitive decline and disease severity, making EEG a potential tool for early detection and monitoring of disease progression [3].

Magnetoencephalography (MEG) is another neurophysiological technique that measures the magnetic fields generated by neural activity. MEG provides high temporal and spatial resolution, allowing for detailed mapping of brain function. In Parkinson's disease, MEG can detect changes in beta-band oscillations, which are linked to motor symptoms and response to treatment. This capability makes MEG a valuable tool for assessing disease impact and tailoring therapeutic interventions [4].

Evoked potentials (EPs) are electrical responses generated by the brain in reaction to sensory stimuli. Various types of EPs, including visual evoked potentials (VEPs) and somatosensory evoked potentials (SEPs), can be used to evaluate specific neural pathways affected by neurodegenerative diseases. In multiple sclerosis, for example, prolonged EP latencies indicate demyelination and can help assess disease activity and treatment efficacy [5].

Transcranial magnetic stimulation (TMS) involves applying magnetic pulses to the scalp to modulate cortical excitability and assess neural function. TMS can provide information about motor cortex activity and connectivity, which is relevant in conditions like ALS and Parkinson's disease. Changes in motor evoked potentials (MEPs) and cortical inhibition observed with TMS can reflect disease progression and guide therapeutic strategies [6].

The discovery of neurophysiological biomarkers involves extensive research to identify reliable indicators of disease state and progression. Validation is a critical step, ensuring that identified biomarkers are reproducible, specific, and sensitive to changes in disease status. This process often requires large-scale studies and collaboration between researchers, clinicians, and industry partners to establish the clinical utility of these biomarkers [7].

The integration of neurophysiological biomarkers into clinical practice involves developing standardized protocols for their measurement and interpretation. This includes establishing reference ranges, understanding variability across different patient populations, and incorporating biomarkers into existing diagnostic and monitoring frameworks. Effective integration can enhance the accuracy of diagnosis, enable early intervention, and improve patient outcomes [8].

Despite their potential, neurophysiological biomarkers face several challenges, including variability in patient responses, technical limitations of measurement techniques, and the need for extensive validation. Additionally, the complexity of neurodegenerative diseases means that no single biomarker can provide a complete picture. Therefore, a multimodal approach, combining neurophysiological data with other diagnostic tools, is often necessary for comprehensive disease assessment [9].

Future research in neurophysiological biomarkers will likely focus on refining existing techniques, exploring novel biomarkers, and enhancing the sensitivity and specificity of

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measurements. Advances in technology, such as high-density EEG and advanced signal processing algorithms, may offer new insights into disease mechanisms and improve clinical applications. Personalized medicine approaches, incorporating biomarkers into individualized treatment plans, will also be a key area of development [10].

## Conclusion

Neurophysiological biomarkers represent a promising frontier in the management of neurodegenerative diseases, offering valuable insights into neural function and disease progression. From early detection to treatment monitoring, these biomarkers have the potential to transform clinical practice and improve patient outcomes. Continued research, validation, and integration into clinical workflows will be crucial for realizing the full potential of neurophysiological biomarkers in neurodegenerative diseases.

## References


1. Koníčková D, Menšíková K, Tučková L, et al. Biomarkers of neurodegenerative diseases: Biology, taxonomy, clinical relevance, and current research status. Biomedicines. 2022;10(7):1760.
2. Krawczuk D, Kulczyńska-Przybik A, Mroczko B. Clinical Application of Blood Biomarkers in Neurodegenerative Diseases—Present and Future Perspectives. Int J Mol Sci. 2024;25(15):8132.
3. Henley SM, Bates GP, Tabrizi SJ. Biomarkers for neurodegenerative diseases. Curr Opin Neurol. 2005;18(6):698-705.
4. Carreiro AV, Mendonça A, de Carvalho M, et al. Integrative biomarker discovery in neurodegenerative diseases. Wiley Interdiscip Rev Syst Biol Med. 2015;7(6):357-79.
5. Jeromin A, Bowser R. Biomarkers in neurodegenerative diseases. Neurodegenerative diseases: pathology, mechanisms, and potential therapeutic targets. 2017:491-528.
6. Chen-Plotkin AS. Unbiased approaches to biomarker discovery in neurodegenerative diseases. Neuron. 2014;84(3):594-607.
7. Lausted C, Lee I, Zhou Y, et al. Systems approach to neurodegenerative disease biomarker discovery. Annu Rev Pharmacol Toxicol. 2014;54(1):457-81.
8. Ganesalingam J, Bowser R. The application of biomarkers in clinical trials for motor neuron disease. Biomark Med. 2010;4(2):281-97.
9. Hampel H, Toschi N, Babiloni C, et al. Revolution of Alzheimer precision neurology. Passageway of systems biology and neurophysiology. J Alzheimers Dis. 2018;64(s1):S47-105.
10. Baldacci F, Lista S, Garaci F, et al. Biomarker-guided classification scheme of neurodegenerative diseases. J Sport Health Sci. 2016;5(4):383.



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