

The application and therapeutic utility of wearable devices in Parkinson's disease and stroke: current state of evidence

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Wearable devices have emerged as promising tools to support objective assessment, monitoring, and rehabilitation in neurological disorders. Parkinson's disease (PD) and stroke, despite their differing pathophysiology, share functional consequences including impaired motor control, gait disturbance, and reduced independence, thereby creating overlapping opportunities for technology-enabled clinical support. Devices range from accelerometers, wristwatches, limb sensors, as well as motion and force sensors to emerging electrochemical platforms. These systems aim at optimising medication and facilitating real-time symptom tracking, remote monitoring, and rehabilitation assistance. We have performed an extensive literature review on the field of the use of wearable devices in PD and stroke; our objectives included consolidating current evidence for PD- and stroke-focused wearable devices, outlining strengths, technical capabilities, clinical practicality, and barriers to real-world deployment. Wearables were surveyed by clinical function and sensing modality. In PD, wearables were predominantly used for the characterization of motor symptoms and treatment response, including accelerometry for tremor, bradykinesia, and motor fluctuation, inertial and force sensors for gait and balance analysis, and emerging biochemical sensing for pharmacological monitoring [1]. The most frequently applied types of wearable de-

vices are accelerometers, motion and force sensors, and electrochemical sensors. Accelerometers are the most extensively researched PD sensors, providing highly specific, real-time symptom tracking (particularly for bradykinesia and motor fluctuations, which correlate closely with dopaminergic levels); thus, they have the potential to reliably monitor treatment efficacy and its chronopharmacological aspects [2]. Similarly, force and motion sensors represent another category of wearable devices frequently utilised for the monitoring of gait and fine hand movements in PD. More recently, early-stage electrochemical sensor-based studies have been designed for the continuous monitoring of the optimal timing and dose of PD medications, by continuously estimating, for example, levodopa levels in the interstitial fluid of PD patients. In stroke, wearables support rehabilitation *via* activity trackers, limb sensors, instrumented footwear, and sensor-assisted orthoses in order to quantify movement, promote repetition, and support home therapy [3]. The most frequently used wearable devices in stroke include shoe insoles, wristwatches, limb sensors, and robotic gloves. Different shoe inserts have been researched in hope of improving the management of gait abnormalities after stroke, assisting rehabilitation, and transmitting kinesiological data to the treating physicians for remote assessment. Wristwatches have also been recruited with the aim to

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increase post-stroke recovery: they monitor baseline activity and walking distance throughout the day as well as during exercises, and remind patients to perform exercises, thereby improving consistency, motivation, and the function of the affected limb. Limb sensors have been employed in studies optimising remote management *via* exercise tracking with features allowing them to monitor muscle activity and gait symmetry aiming at preventing falls. Finally, robotic and smart gloves represent the most extensively studied wearable devices in post-stroke rehabilitation, aiming to improve fine motor control and to restore upper limb function. Wearable devices increasingly integrate digital feedback systems and remote data transmission. While feasible and sensitive to clinically relevant changes, the assessed studies were limited by methodological variabilities, small-cohort sizes, short follow-ups, and inconsistent benchmarking. Wearable technologies provide a shared technological foundation for addressing motor dysfunction in PD and stroke, thereby providing a context-aware assessment. Clinical impact is likely to expand with improved standardisation, robust longitudinal evaluation, and closer alignment with clinical workflows and patient-centred outcomes.

Keywords

individualised therapeutics; Parkinson's disease; rehabilitation; stroke; wearable devices

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Conflicts of interest statement

None to declare.

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