

# Chapter 64

## Trends and New Advances on Wearable and Mobile Technologies for Parkinson's Disease Monitoring and Assessment of Motor Symptoms: How New Technologies Can Support Parkinson's Disease

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### ABSTRACT

*The aim of this work is to analyze the trends and new advances carried out in the last decades in the field of Parkinson's disease monitoring and management and more specifically regarding wearable and mobile technologies. The challenges of such technologies is to monitor, to assess and to manage the full range of PD symptoms through monitoring and testing routines while not hampering the patient's daily activities, identifying the correlation between the different dimensions affecting the severity of symptoms and the evolution of the disease and enabling the clinician to manage more efficiently the patient by providing timely indications on the effectiveness of the therapy and suggestions on therapy changes.*

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## **INTRODUCTION**

Parkinson's disease (PD) is a degenerative neurologic disease. Degenerative means "declining in quality"; thus, it increases in severity over time and neurologic refers to the nervous system. Therefore, PD is a disease of the nervous system that gets worse over time. It is also a chronic, progressive neurologic disease. Chronic means "of long duration" and progressive means "proceeding in steps" or "advancing". PD does not go away and it gradually gets worse (Weiner, Shulman, & Lang, 2013). Although it is possible that it starts earlier, PD is extremely linked with age and the average onset age is after 60 years old. For this reason, due to the current trends of population ageing, PD is getting more and more significant in several countries. To many people, the term Parkinson's disease is synonymous to having a tremor. However Parkinson's disease is much more than suffering a tremor (Perkin, 1998; Tugwell, 2008), though this is indeed one feature of the disease that occurs in the majority of patients. Equally, there are many causes for having a tremor apart from Parkinson's disease. The cardinal features of PD are resting tremor, rigidity, bradykinesia (or slowness) and gait disturbance with disequilibrium (Obeso, Olanow, & Nutt, 2000). PD is an age-related illness primarily affecting the elderly population and often resulting in a marked decline in the quality of life of both patients and caregivers (Cubo et al., 2005). Parkinson's disease is a progressive neurodegenerative condition characterized and diagnosed by the presence of motor and non-motor symptoms (Lebouvier et al., 2010). Symptoms tend to appear gradually, normally in just one side of the body at first, although both sides will be affected as Parkinson's progresses. PD follows a slowly chronic progressive course, and the motor cardinal symptoms of the disease appear only when the degenerative process has progressed for a long time (Lebouvier et al., 2010), in most cases probably for more than 10 years (Hawkes, Del Tredici, & Braak, 2007). Currently, diagnosis and progression of PD is based mainly on clinical criteria. Diagnosis of PD relies on the presence of two out of three of major motor signs, namely tremor, bradykinesia, and hypertonía, implying that the diagnosis is made only many years after the real onset of the neurodegenerative process (Hughes, Daniel, Ben-Shlomo, & Lees, 2002).

## **BACKGROUND**

The concept of monitoring individuals in the home and community settings was introduced more than 50 years ago, when Holter monitoring was proposed (in the late 1940s) and later adopted (in the 1960s) as a clinical tool. However, technologies to fully enable such vision were lacking and only sporadic and rather obtrusive monitoring techniques were available for several decades (Paolo Bonato, 2010). Recent advances in mobile and wearable technology have provided means to supplement the information gathered using tools based on patient's direct observation as well as interviews and questionnaires. The growth of mobile technologies has been raising in the last decades for general purpose, and consequently a new generation of wearable sensors and systems has recently become available thus providing clinical personnel with a "window of observation" in the home and community settings. These tools allow one to capture patients' activity level and exercise compliance, facilitate titration of medications in chronic patients, and provide means to assess the ability of patients to perform specific motor activities (Paolo Bonato, 2009). Wireless Body Area Networks (WBANs) of intelligent sensors represent an emerging technology for system integration with great potentials for unobtrusive ambulatory health monitoring during extended periods of time (E. Jovanov, 2005).

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