



Wearable-Sensor System for Monitoring Motor Function in Parkinson's Disease

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Statement of the Problem

The majority of people with Parkinson's disease have a variety of involuntary movement disorders that become less manageable as their disease progresses. Treatments are difficult to manage through the current reliance on self-report measures, such as motor diaries.

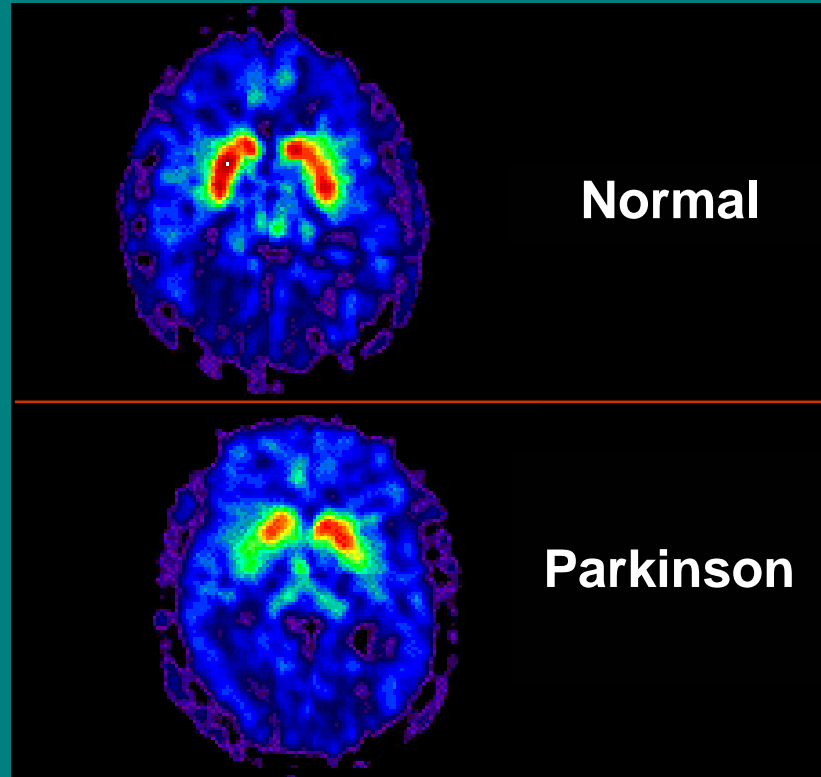
Solution

A wearable monitoring system that automatically identifies and tracks the severity of the movement disorders and the functional mobility status of the patient in response to treatment.





What is Parkinson's Disease?



Loss of cells in the brain (red) prevent normal activation of muscles. The patient experiences a loss of mobility, movement disorders, and difficulty adjusting medication.





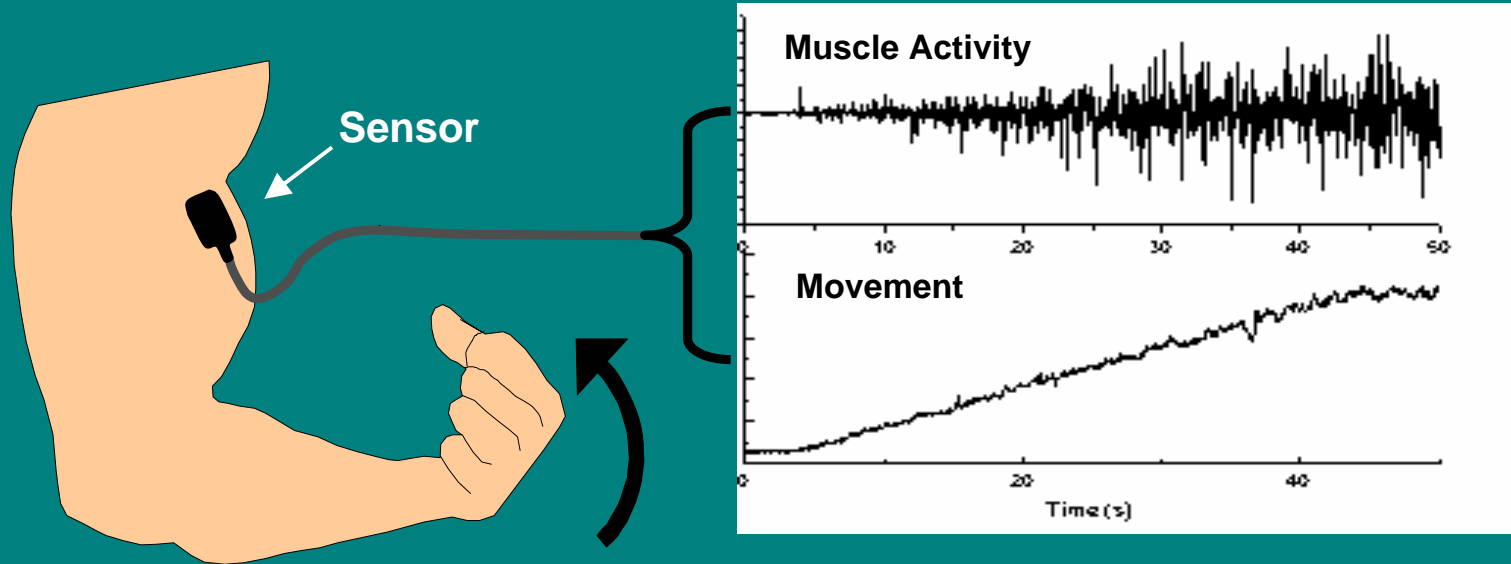
Major Issues of Concern

- **Diminished Mobility**
- **Involuntary Movements (Motor Disorders)**
- **Problems with Medication:**
 - **Diminishing effectiveness (Wearing off)**
 - **Abnormal movements (Dyskinesia)**



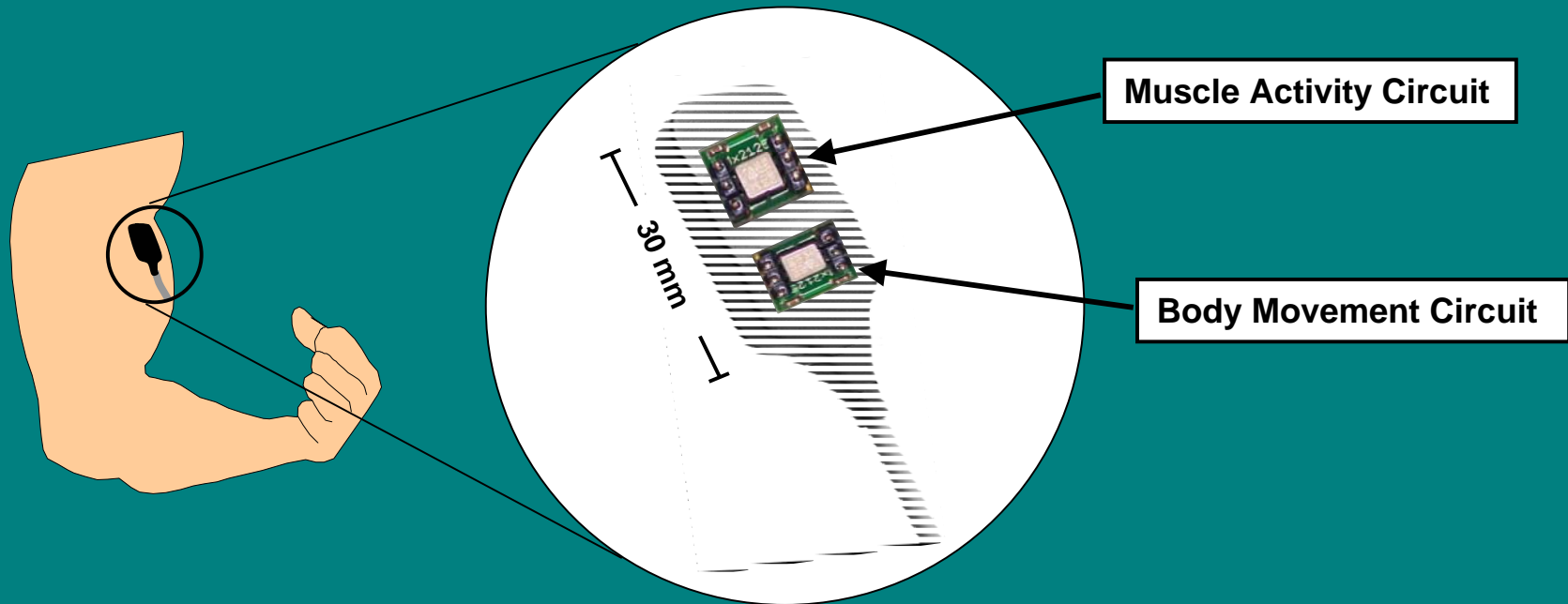
Approach

- Mobility, Motor Disorder, and Medication states are monitored by sensors placed on the body.
- These sensors detect muscle activity and body movement.



Sensor Technology

A novel sensor technology was developed to integrate the electronic components for muscle activity and body movement into a single compact design





Two-phase Approach



Using the muscle activity and body movement signals gathered from these sensors, we are developing a two-phase approach to creating the wearable-sensor system:

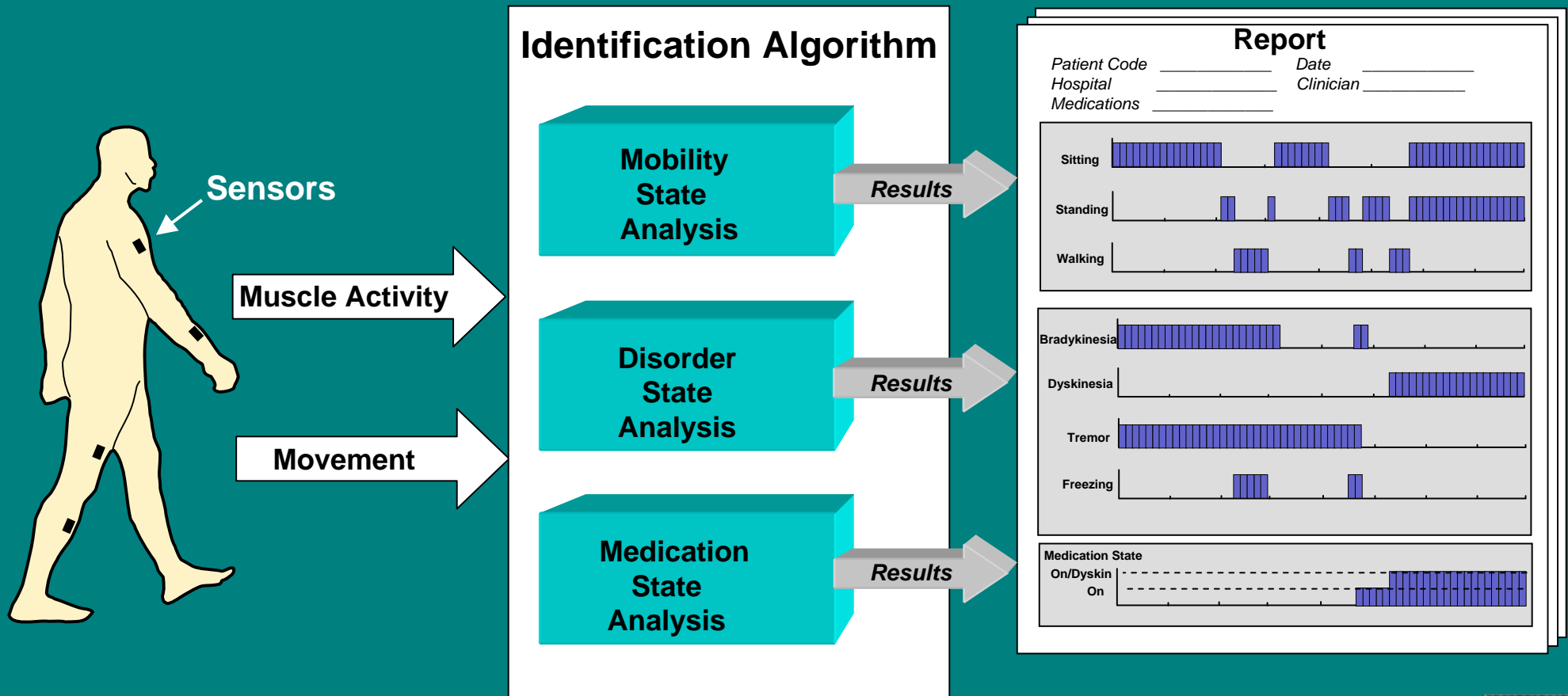
- Phase I (Current): Develop an algorithm to identify Mobility, Motor Disorder, and Medication states
- Phase II (Future): Design a portable system for clinical use





Phase I (Current): Algorithm Development

We are developing intelligent algorithms to identify the movement disorder state, medication state, and mobility state from sensors on the body





Phase I - Research Design



Data Collection

- Laboratory is set up as an apartment
- Patients are free to move about while monitored by the sensors and a video camera

Data Analysis

- Algorithm results are compared to results from video-based analysis by a clinician



Example 1: Videos

Assisted Walking (Medication is Working)



[Click here to view video.](#)

Freezing Gait (Medication has Worn Off)



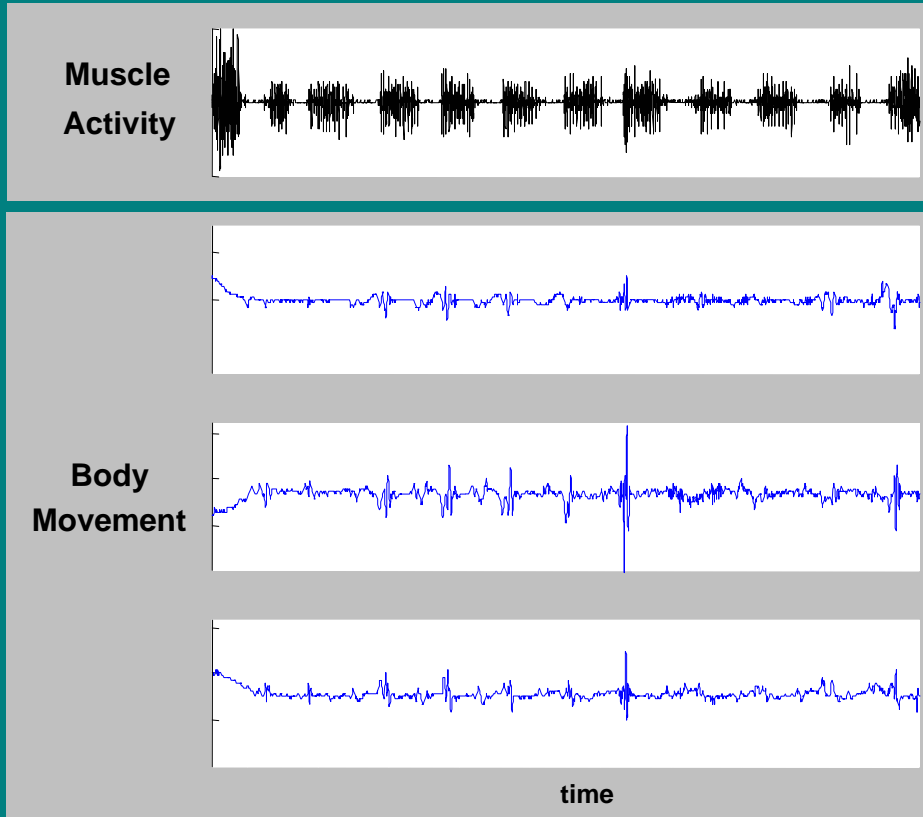
[Click here to view video.](#)



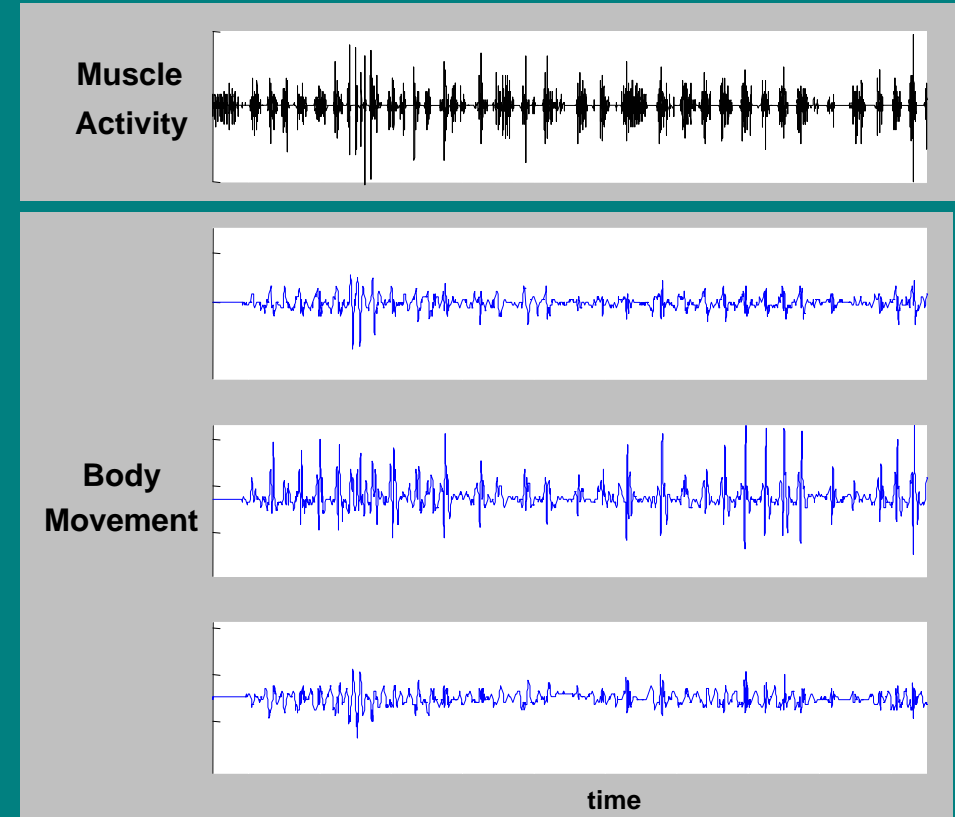
Example 1: Signals



Assisted Walking (Medication is Working)



Freezing Gait (Medication has Worn Off)



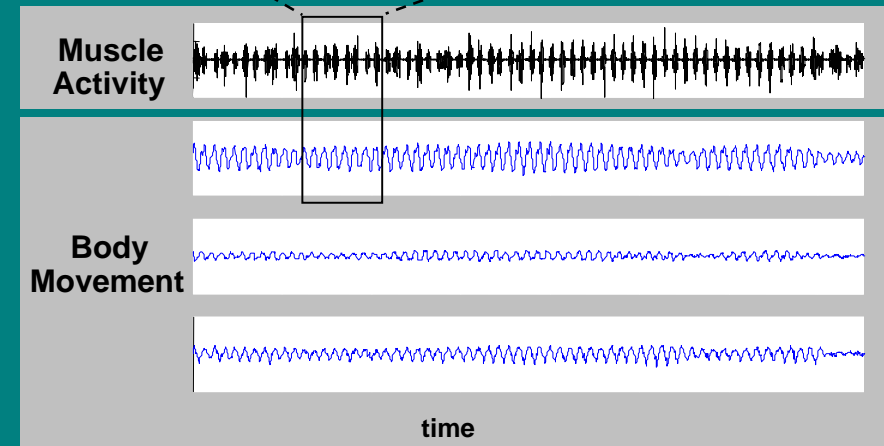
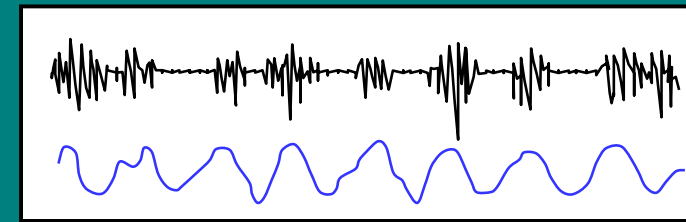
Example 2: Tremor - Video and Signals

Tremor
(Medication has Worn Off)



[Click here to view video.](#)

Tremor Signal
pattern



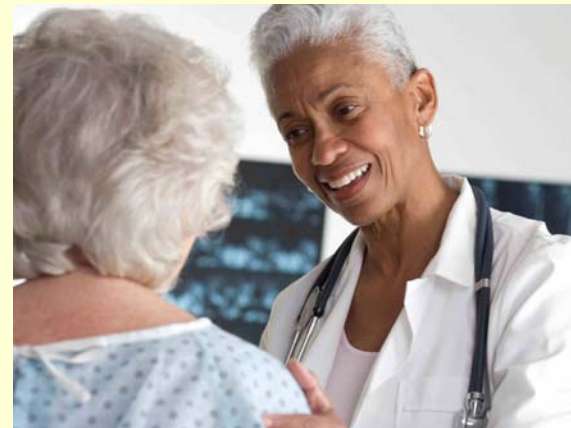


Phase I: Results to Date

An algorithm was developed that identifies the following states with better than 90% accuracy:

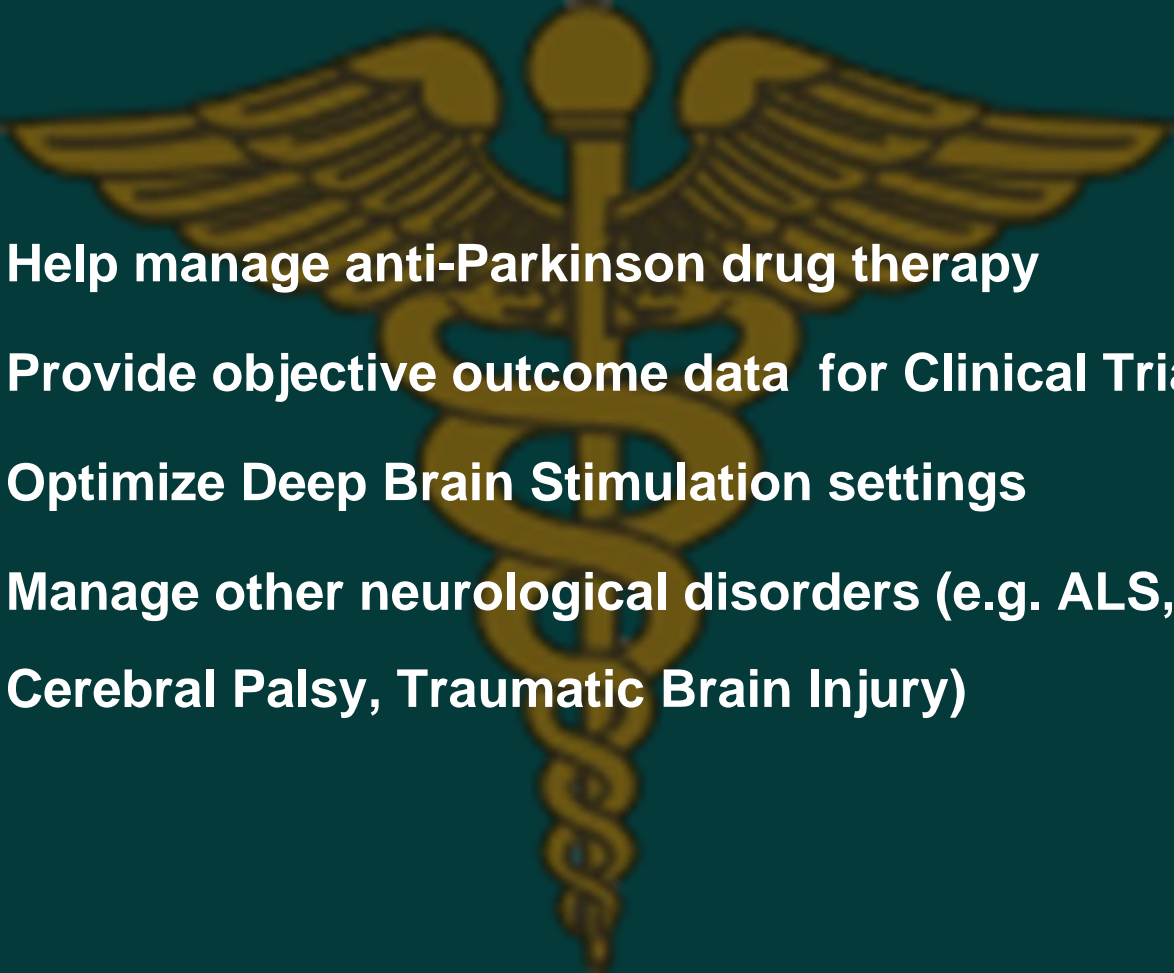
- **Mild to severe motor disorders of Parkinson's disease (Tremor and Freezing)**
- **Mild to severe motor disorders resulting from effects of anti-Parkinson's medication (Dyskinesia)**
- **The patient's mobility states (sit, stand, walk, lie down)**

These results provide a more comprehensive and accurate assessment compared to previous approaches.





Applications

- 
- **Help manage anti-Parkinson drug therapy**
 - **Provide objective outcome data for Clinical Trials**
 - **Optimize Deep Brain Stimulation settings**
 - **Manage other neurological disorders (e.g. ALS, Cerebral Palsy, Traumatic Brain Injury)**





We are Currently Using this Technology to Monitor Parkinson's Disease Patients with Deep Brain Stimulation NIH/NIBIB Supplement

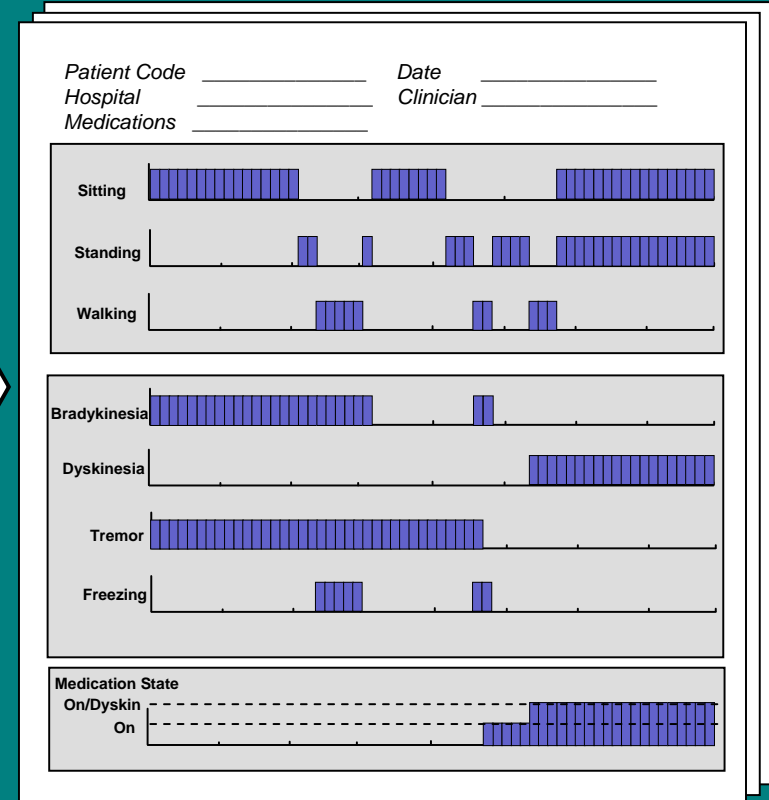
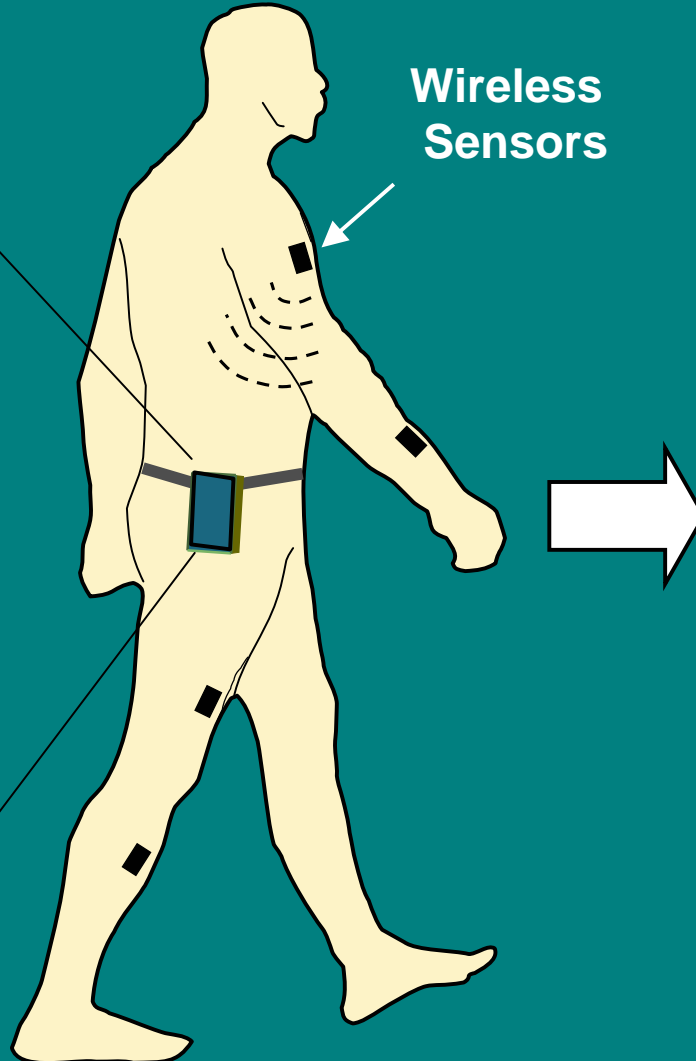
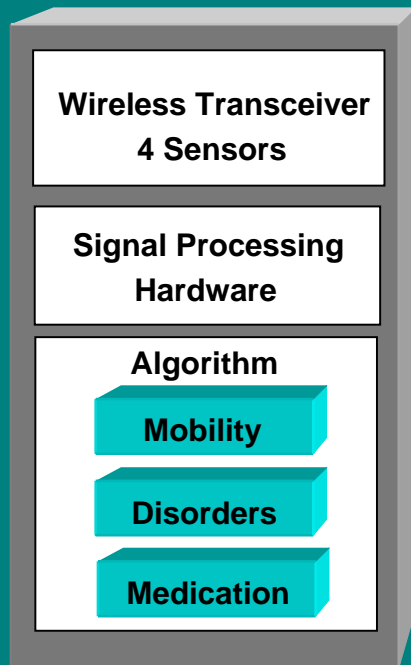


Phase II (Future): Wireless Device

**Belt-mounted
Wireless Data
Collection Device**

**Wireless
Sensors**

**Customized Report for
Clinician & Patient**



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