# Quantitative Home-Based Monitoring of Parkinson's Disease Motor Symptoms

Dustin A. Heldman[1], Thomas O. Mera[1], Alberto J. Espay[2], Megan Payne[2], Joseph P. Giuffrida[1]

GREAT LAKES NEUROTECH

[1]Great Lakes NeuroTech Inc., Cleveland, OH [2]University of Cincinnati Neuroscience Institute, Department of Neurology, Gardner Center for Parkinson's disease and Movement Disorders, University of Cincinnati, Cincinnati, OH.

UNIVERSITY OF Cincinnati

## Introduction

The current standard for evaluating motor impairment associated with Parkinson's disease (PD) is the motor subscale of the Unified Parkinson's Disease Rating Scale (UPDRS-III), a qualitative assessment completed during an office visit. However, these single assessments provide only a snapshot of motor impairment and do not adequately reflect symptom fluctuations in response to medications throughout the day. Therefore, the objective of this study was to evaluate a home-based system for quantifying PD motor symptoms throughout the day in response to medication.

## Methods

Ten subjects with idiopathic PD (Table 1) used Kinesia HomeView™ (Great Lakes NeuroTech Inc, Figure 1) at home for five consecutive days. Additionally, ten healthy controls used the system for a single session in a controlled laboratory.



**Figure 1.** Kinesia HomeView includes a wireless finger-worn sensor unit (left) and a touch screen tablet PC with a USB docking station for the sensor unit (right).

**Table 1. PD Subject Demographics**

| | |
|---|---|
| Age (yr) | 61.4 ± 7.4 |
| Gender (m/f) | 8/2 |
| Levodopa Equivalent Daily Dose (mg) | 1511±933 |

The system includes a wireless finger-worn sensor containing accelerometers and gyroscopes for measuring three-dimensional motion and a touch screen tablet PC that guided patients through an automated motor assessment (Figure 2). Each assessment took approximately five minutes to perform and was repeated five times per day. After each assessment, previously developed algorithms scored tremor, bradykinesia, hypokineisa, and dysrhythmia on a 0 - 4 severity scale using the kinematic data. Additionally, timing of medication dosage was recorded via the Kinesia HomeView diary. To ensure subjects performed the assessments correctly in the home, compliance criteria were developed from kinematic data recorded in the control subjects.

Rest Tremor    Postural Tremor    Kinetic Tremor
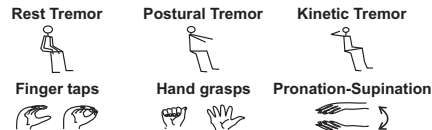
Finger taps    Hand grasps    Pronation-Supination

Figure 2. The Kinesia HomeView software includes instructional videos and scoring algorithms for several tasks commonly used to evaluate PD motor symptoms.

## Patient Compliance

**Table 2. Motor Task Compliance Outcome**

| Motor Task | Voluntary Movement (% Correct) | | Task-Specific (% Correct) | |
|---|---|---|---|---|
| | Control | PD | Control | PD |
| Rest Tremor | 100 | 95 | 90 | 95 |
| Postural Tremor | 100 | 100 | 100 | 93 |
| Kinetic Tremor | 100 | 100 | 100 | 99 |
| Finger Taps | 100 | 100 | 100 | 100 |
| Hand Grasps | 100 | 100 | 100 | 100 |
| Pronation-Supination | 100 | 100 | 100 | 100 |

Kinematic data was used to determine if subjects were performing the tasks correctly in the home. Compliance criteria were based on the presence of voluntary motion as well as kinematic features specific to each task. Over 97% of tasks were preformed correctly.
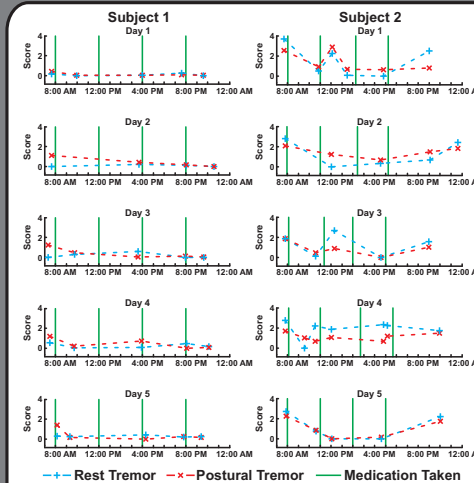
## Home Monitoring



Figure 3. Sample data for two of the subjects who performed the automated motor assessment four to six times per day for five consecutive days. Scores given by the Kinesia HomeView system are marked each time the assessment was performed. Subject 1's tremor is very well controlled throughout the day, while Subject 2 experiences large fluctuations.

Legend: Rest Tremor (+), Postural Tremor (×), Medication Taken
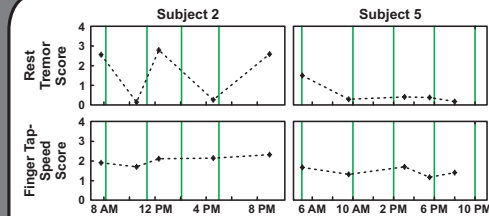
## Motor Response to Medication



**Figure 4.** Sample rest tremor and finger tap speed (bradykinesia) scores for two subjects during a single day. Dotted vertical lines indicate when medication was taken. Subject 2's tremor fluctuates throughout the day, while Subject 5's rest tremor is well controlled. Bradykinesia does not respond well to medication for either subject.
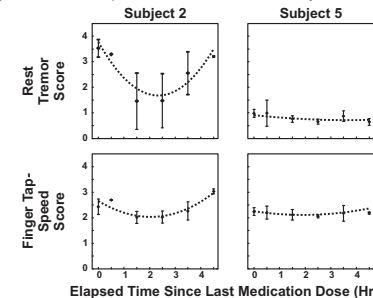


**Figure 5.** Medication Dose Cycle Motor Response. Motor scores were grouped into one hour intervals based on the elapsed time since the previous medication dose. Baseline scores were aligned with time zero. Error bars represent the standard deviation of the motor scores in each time interval. Second order equations were fit to the plotted data (dotted curves). Subject 2's symptoms returned well before the next dose of medication while Subject 5's remained well under control.

## Conclusions

The Kinesia HomeView system allows for more continuous monitoring, enabling the capture of motor fluctuations occurring throughout the day in relationship to medication cycles. Clinicians can utilize fluctuation reports to better tune medication regimens and decrease fluctuations. Additionally, this increased temporal resolution may aid in the evaluation of novel treatments.