Towards Ambulatory Motor Monitoring: Measuring Dyskinesia During Activities of Daily Living

Webinar Will Begin at 12:00 PM EDT
Outline

• Motor Fluctuations and Levodopa-induced Dyskinesia
• Challenges with Clinical Dyskinesia Assessment
• Intelligent Algorithms for Continuous Monitoring of Dyskinesia
• Motor Fluctuations
  – Alternate between “OFF” and “ON” states over dose cycle

• Levodopa-induced Dyskinesia
  – Involuntary, episodic, and irregular movements
  – Most commonly occur at peak dose

Keijsters et al., Movement Disorders 18(1), 2003
Patient Impact

https://www.youtube.com/watch?v=CaJymwziF-M
New Therapy Development

ClinicalTrials.gov
A service of the U.S. National Institutes of Health

Search for studies:
Advanced Search | Help | Studies by Topic | Glossary

407 studies found for: dyskinesia and parkinson's

PROGRAM GOAL
The Michael J. Fox Foundation for Parkinson's Research (MJFF) wishes to engage researchers and drug makers focused on studying and/or therapeutically treating levodopa-induced dyskinesia (LID). Applicants may submit a proposal focused on a relevant area of LID research (see full details below) for consideration of a one-year, $125,000 award. See the Special Requirements section below for additional information.
Clinical Assessment of Dyskinesia

In-Clinic Assessment

- Rating scales **only provide a temporal snapshot** of dyskinesia response, limited resolution

Patient Diaries

- Self-assessment at home at regular intervals, **confounded by patient awareness, compliance**
Technology-based Assessment

Touch Interfaces

Motion Sensors

Objective, high resolution measurement + Remote access

Mobile Data Networking
What exactly do motion sensors capture?
Tremor can be differentiated from voluntary motion by taking advantage of separation in the frequency spectrum.
Same principles can be used to quantify dyskinesia when there is no voluntary motion

Mera et al., Journal of Parkinson’s Disease 3(3), 2013
Quantifying dyskinesia during routine activities is significantly more challenging because of kinematic and spectral overlap.
Motion Sensor Dyskinesia
Quantification During ADLs

- Motion sensor units positioned on hand, thigh, and heel
- Representative scripted ADLs performed over a 3-hr period after levodopa dose
- Motion sensor data saved, videos scored by blinded raters using m-AIMS
1. Develop an intelligent algorithm that can rate dyskinesia severity across a range of routine activities
2. Determine a minimal set of motion sensors to minimize patient burden
• Patients perform tasks throughout dose cycle, capturing range of severities
• Movement recorded by camera and wireless motion sensors
• Blinded clinicians score dyskinesia using modified AIMS scale
• Kinematic features extracted from motion data using signal processing techniques
• Algorithms trained to predict dyskinesia severity rating from kinematic feature(s)
Process Workflow

- Process repeated using different combinations of sensors and locations
Severity Scoring Model

- Linear regression models were developed to predict total mAIMS score averaged across both raters using kinematic features as inputs.
**Hair Brushing**

R = 0.88  
RMSE = 0.35

**Cutting Food**

R = 0.91  
RMSE = 0.37

**Drinking from a Cup**

R = 0.85  
RMSE = 0.41

**Bagging Groceries**

R = 0.91  
RMSE = 0.37

**Dressing**

R = 0.89  
RMSE = 0.39
Conclusions

• A motion sensor system can accurately capture dyskinesia during routine activities
  – Provide an objective tool for quantifying motor symptom fluctuation in the context of daily life

• Ongoing study to validate algorithms in ambulatory setting
Current Commercial Technology
## Capturing Fluctuations

<table>
<thead>
<tr>
<th>Time</th>
<th>Rest Tremor</th>
<th>Postural Tremor</th>
<th>Finger Taps Speed</th>
<th>Finger Taps Amplitude</th>
<th>Finger Taps Rhythm</th>
<th>Dyskinesia</th>
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**Drug Dose A**
Pre-defined Tasks

Discrete Points in Time

In Front of Tablet PC

Routine ADLs

“Continuously”

Anywhere
Upcoming Features

• Moving towards system that can easily provide objective measures of **medication state** and **physical mobility** with minimal patient burden through continuous monitoring.
Acknowledgements

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Questions?

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