Continuous Motor Monitoring: Implementation and Value

Webinar Will Begin at 12:00 PM EDT

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Outline

- Standard and technology-based assessment of motor symptoms
- Kinesia HomeView overview
- Motion sensor rating tremor in a laboratory setting during activities of daily living
- Continuous motion sensor rating of tremor at home

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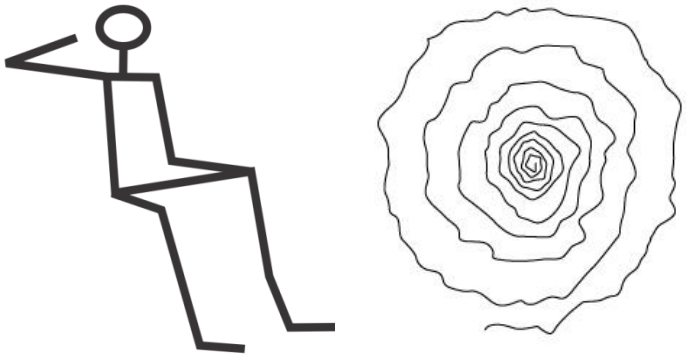
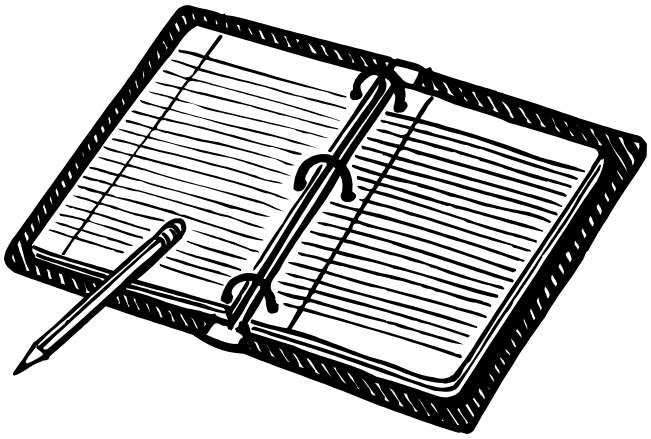
Standard Assessment of Involuntary Motor Symptoms

Clinician Ratings



- Limited resolution
- Limited reliability
- Placebo effects

Patient Diaries



- Compliance
- Recall bias
- Poor self-assessment

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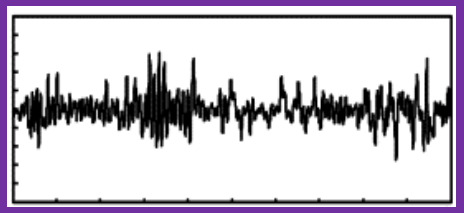
Technology-based Assessment

Touch Interfaces

Motion Sensors



Mobile Data Networking

Objective, high resolution measurement

\+

Remote access

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Kinesia HomeView

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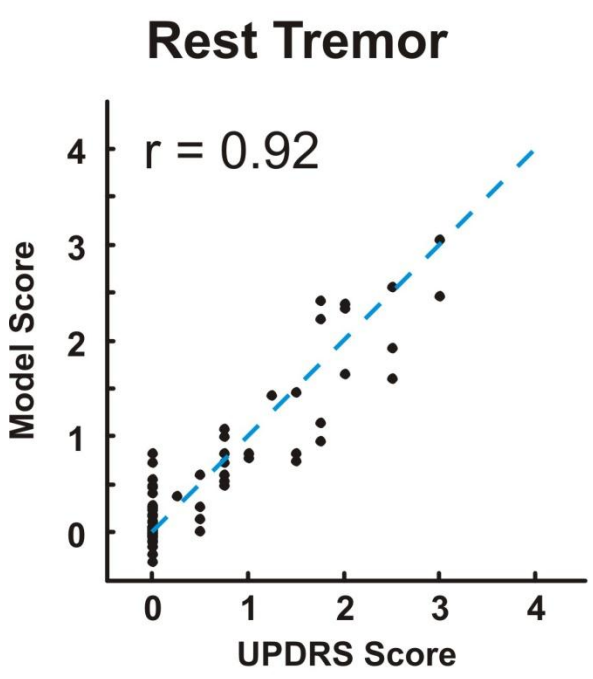
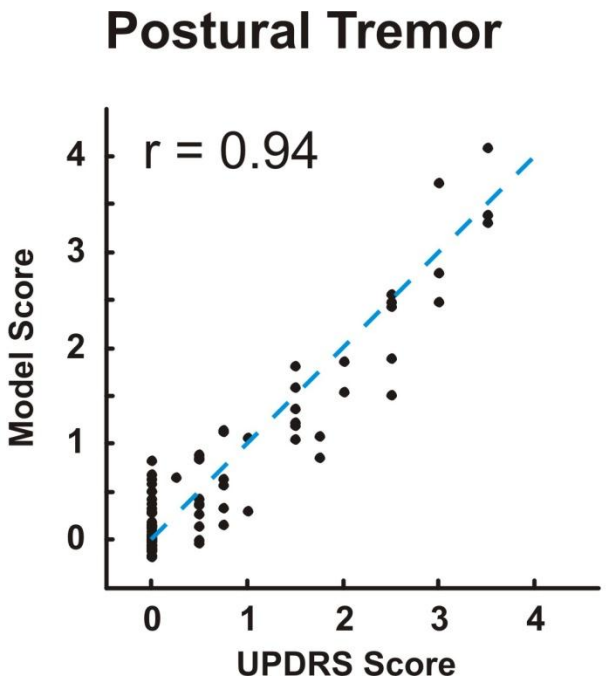
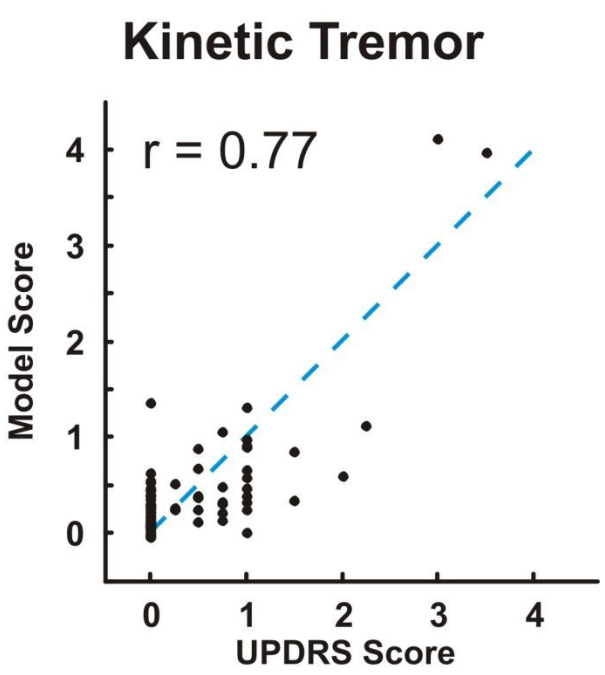
Clinical Validation - Tremor







Published

Giuffrida, J. P., Riley, D, Maddux, B, and Heldman, D.A. Clinically deployable Kinesia technology for automated tremor assessment. *Movement Disorders* 24 (5): 723-730, 2009.

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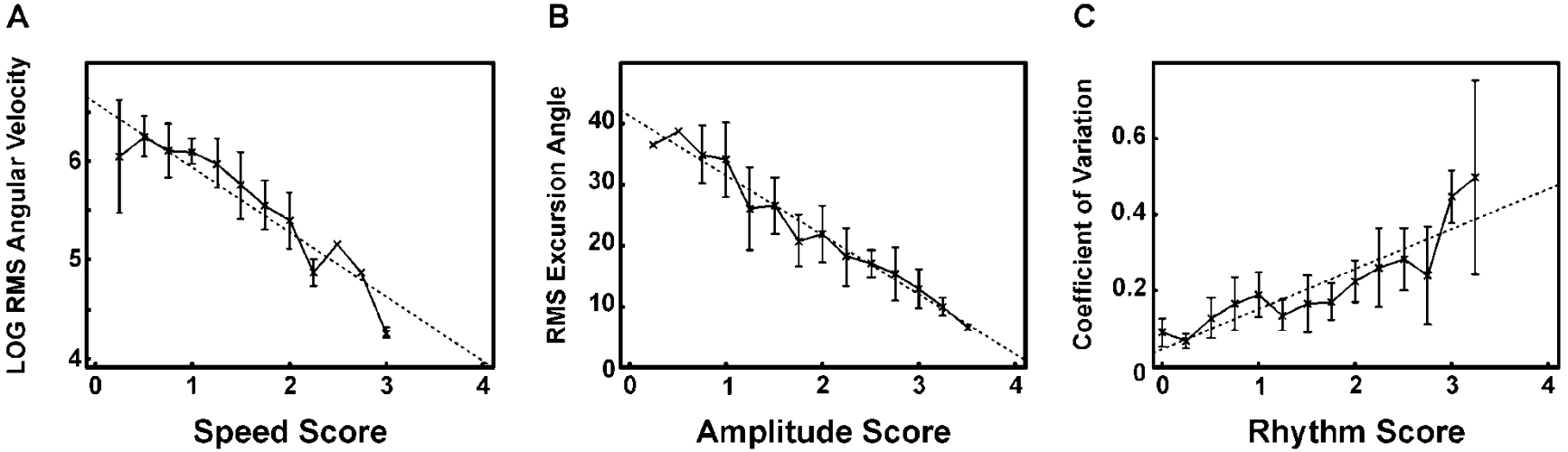
Clinical Validation - Bradykinesia



Objective Quantification

Kinematic features are highly correlated to clinician MBRS scores

Published

Heldman, DA; Giuffrida, JP; Chen, R; Payne, M; Mazzella, F; Duker, AP; Sahay, A; Kim, SJ; Revilla, FJ; Espay, AJ. The Modified Bradykinesia Rating Scale for Parkinson's disease: Reliability and Comparison with Kinematic Measures. *Movement Disorders*. 2011.

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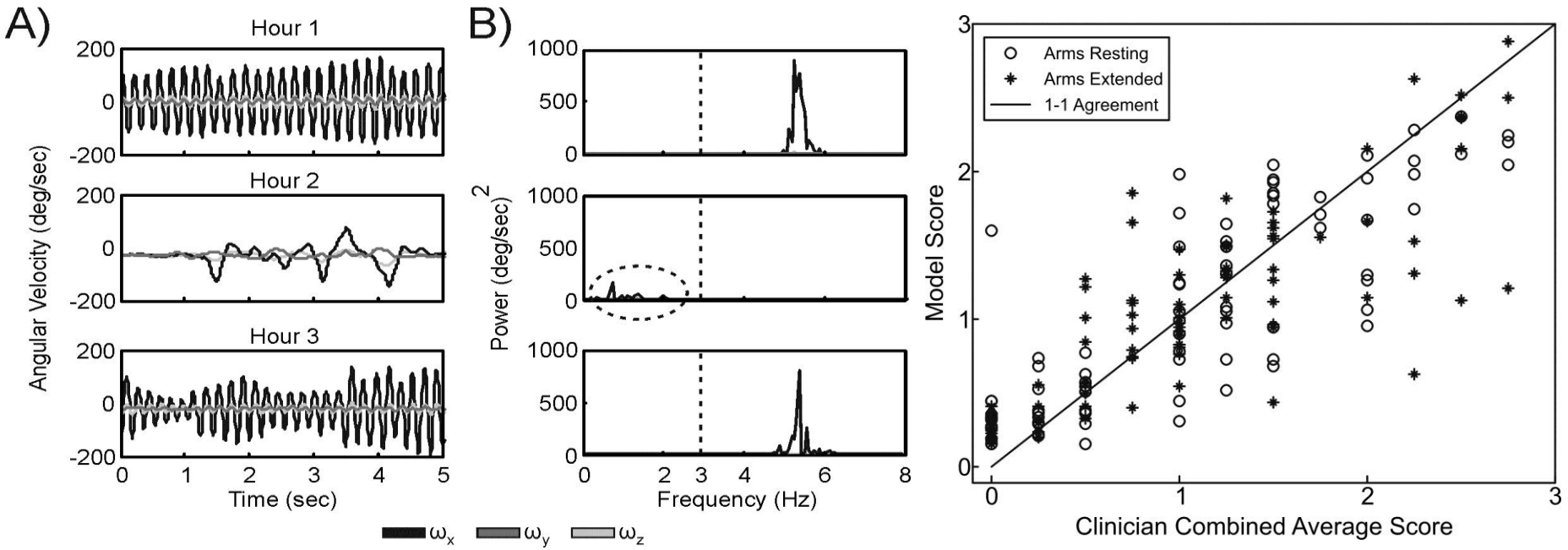
Clinical Validation - Dyskinesia



Published

Mera, TO, Burack, MA, and Giuffrida, JP. "Quantitative Assessment of Levodopa Induced Dyskinesia Using Automated Motion Sensing Technology", IEEE-EMBS Proceedings 2012.

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Capturing Fluctuations

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
7:01 AM	4.0	3.5	2.5	2.4	2.2	0.0
7:02 AM	SINEMET (100mg)					
7:32 AM	3.4	3.3	1.7	1.4	1.0	0.0
8:01 AM	3.0	3.0	1.8	1.8	1.2	0.0
8:34 AM	2.9	2.8	1.3	1.2	1.0	0.0
9:00 AM	2.8	2.4	1.2	1.1	1.2	0.0
9:23 AM	2.8	2.6	1.0	1.0	1.0	0.0
10:00 AM	2.6	2.8	1.0	1.0	1.0	0.0
10:33 AM	3.2	3.3	1.5	1.9	1.5	0.0
11:01 AM	3.5	3.5	2.3	2.2	2.0	0.0
11:30 AM	3.7	3.8	2.0	2.0	1.8	0.0

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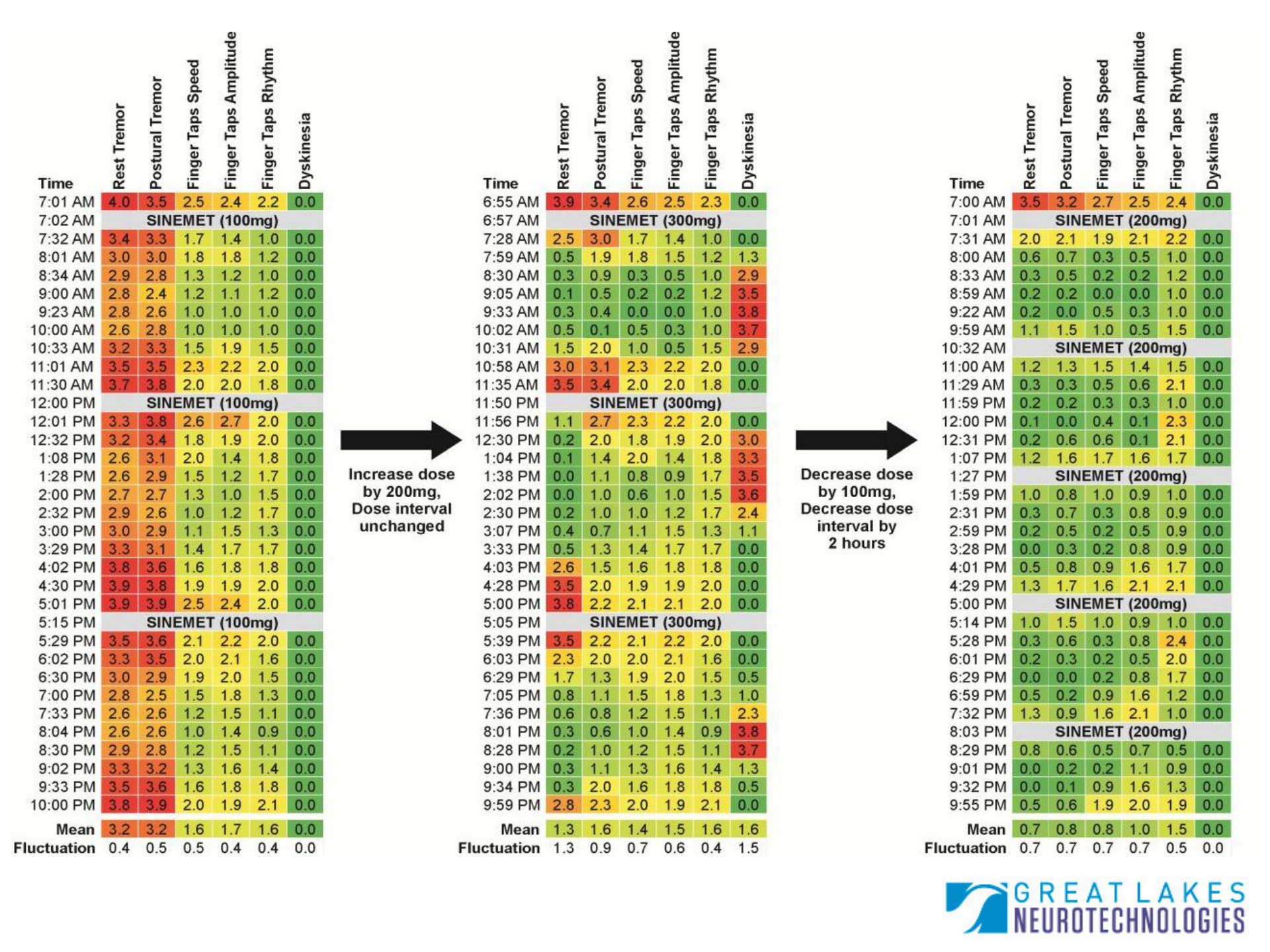
Time
Rest Tremor
Postural Tremor
Finger Taps Speed
Finger Taps Amplitude
Finger Taps Rhythm
Dyskinesia
7:01 AM 4.0 3.5 2.5 2.4 2.2 0.0
7:02 AM SINEMET (100mg)
7:32 AM 3.4 3.3 1.7 1.4 1.0 0.0
8:01 AM 3.0 3.0 1.8 1.8 1.2 0.0
8:34 AM 2.9 2.8 1.3 1.2 1.0 0.0
9:00 AM 2.8 2.4 1.2 1.1 1.2 0.0
9:23 AM 2.8 2.6 1.0 1.0 1.0 0.0
10:00 AM 2.6 2.8 1.0 1.0 1.0 0.0
10:33 AM 3.2 3.3 1.5 1.9 1.5 0.0
11:01 AM 3.5 3.5 2.3 2.2 2.0 0.0
11:30 AM 3.7 3.8 2.0 2.0 1.8 0.0
12:00 PM SINEMET (100mg)
12:01 PM 3.3 3.8 2.6 2.7 2.0 0.0
12:32 PM 3.2 3.4 1.8 1.9 2.0 0.0
1:08 PM 2.6 3.1 2.0 1.4 1.8 0.0
1:28 PM 2.6 2.9 1.5 1.2 1.7 0.0
2:00 PM 2.7 2.7 1.3 1.0 1.5 0.0
2:32 PM 2.9 2.6 1.0 1.2 1.7 0.0
3:00 PM 3.0 2.9 1.1 1.5 1.3 0.0
3:29 PM 3.3 3.1 1.4 1.7 1.7 0.0
4:02 PM 3.8 3.6 1.6 1.8 1.8 0.0
4:30 PM 3.9 3.8 1.9 1.9 2.0 0.0
5:01 PM 3.9 3.9 2.5 2.4 2.0 0.0
5:15 PM SINEMET (100mg)
5:29 PM 3.5 3.6 2.1 2.2 2.0 0.0
6:02 PM 3.3 3.5 2.0 2.1 1.6 0.0
6:30 PM 3.0 2.9 1.9 2.0 1.5 0.0
7:00 PM 2.8 2.5 1.5 1.8 1.3 0.0
7:33 PM 2.6 2.6 1.2 1.5 1.1 0.0
8:04 PM 2.6 2.6 1.0 1.4 0.9 0.0
8:30 PM 2.9 2.8 1.2 1.5 1.1 0.0
9:02 PM 3.3 3.2 1.3 1.6 1.4 0.0
9:33 PM 3.5 3.6 1.6 1.8 1.8 0.0
10:00 PM 3.8 3.9 2.0 1.9 2.1 0.0
Mean 3.2 3.2 1.6 1.7 1.6 0.0
Fluctuation 0.4 0.5 0.5 0.4 0.4 0.0
Increase dose by 200mg, Dose interval unchanged
Time
Rest Tremor
Postural Tremor
Finger Taps Speed
Finger Taps Amplitude
Finger Taps Rhythm
Dyskinesia
6:55 AM 3.9 3.4 2.6 2.5 2.3 0.0
6:57 AM SINEMET (300mg)
7:28 AM 2.5 3.0 1.7 1.4 1.0 0.0
7:59 AM 0.5 1.9 1.8 1.5 1.2 1.3
8:30 AM 0.3 0.9 0.3 0.5 1.0 2.9
9:05 AM 0.1 0.5 0.2 0.2 1.2 3.5
9:33 AM 0.3 0.4 0.0 0.0 1.0 3.8
10:02 AM 0.5 0.1 0.5 0.3 1.0 3.7
10:31 AM 1.5 2.0 1.0 0.5 1.5 2.9
10:58 AM 3.0 3.1 2.3 2.2 2.0 0.0
11:35 AM 3.5 3.4 2.0 2.0 1.8 0.0
11:50 PM SINEMET (300mg)
11:56 PM 1.1 2.7 2.3 2.2 2.0 0.0
12:30 PM 0.2 2.0 1.8 1.9 2.0 3.0
1:04 PM 0.1 1.4 2.0 1.4 1.8 3.3
1:38 PM 0.0 1.1 0.8 0.9 1.7 3.5
2:02 PM 0.0 1.0 0.6 1.0 1.5 3.6
2:30 PM 0.2 1.0 1.0 1.2 1.7 2.4
3:07 PM 0.4 0.7 1.1 1.5 1.3 1.1
3:33 PM 0.5 1.3 1.4 1.7 1.7 0.0
4:03 PM 2.6 1.5 1.6 1.8 1.8 0.0
4:28 PM 3.5 2.0 1.9 1.9 2.0 0.0
5:00 PM 3.8 2.2 2.1 2.1 2.0 0.0
5:05 PM SINEMET (300mg)
5:39 PM 3.5 2.2 2.1 2.2 2.0 0.0
6:03 PM 2.3 2.0 2.0 2.1 1.6 0.0
6:29 PM 1.7 1.3 1.9 2.0 1.5 0.5
7:05 PM 0.8 1.1 1.5 1.8 1.3 1.0
7:36 PM 0.6 0.8 1.2 1.5 1.1 2.3
8:01 PM 0.3 0.6 1.0 1.4 0.9 3.8
8:28 PM 0.2 1.0 1.2 1.5 1.1 3.7
9:00 PM 0.3 1.1 1.3 1.6 1.4 1.3
9:34 PM 0.3 2.0 1.6 1.8 1.8 0.5
9:59 PM 2.8 2.3 2.0 1.9 2.1 0.0
Mean 1.3 1.6 1.4 1.5 1.6 1.6
Fluctuation 1.3 0.9 0.7 0.6 0.4 1.5
Decrease dose by 100mg, Decrease dose interval by 2 hours
Time
Rest Tremor
Postural Tremor
Finger Taps Speed
Finger Taps Amplitude
Finger Taps Rhythm
Dyskinesia
7:00 AM 3.5 3.2 2.7 2.5 2.4 0.0
7:01 AM SINEMET (200mg)
7:31 AM 2.0 2.1 1.9 2.1 2.2 0.0
8:00 AM 0.6 0.7 0.3 0.5 1.0 0.0
8:33 AM 0.3 0.5 0.2 0.2 1.2 0.0
8:59 AM 0.2 0.2 0.0 0.0 1.0 0.0
9:22 AM 0.2 0.0 0.5 0.3 1.0 0.0
9:59 AM 1.1 1.5 1.0 0.5 1.5 0.0
10:32 AM SINEMET (200mg)
11:00 AM 1.2 1.3 1.5 1.4 1.5 0.0
11:29 AM 0.3 0.3 0.5 0.6 2.1 0.0
11:59 PM 0.2 0.2 0.3 0.3 1.0 0.0
12:00 PM 0.1 0.0 0.4 0.1 2.3 0.0
12:31 PM 0.2 0.6 0.6 0.1 2.1 0.0
1:07 PM 1.2 1.6 1.7 1.6 1.7 0.0
1:27 PM SINEMET (200mg)
1:59 PM 1.0 0.8 1.0 0.9 1.0 0.0
2:31 PM 0.3 0.7 0.3 0.8 0.9 0.0
2:59 PM 0.2 0.5 0.2 0.5 0.9 0.0
3:28 PM 0.0 0.3 0.2 0.8 0.9 0.0
4:01 PM 0.5 0.8 0.9 1.6 1.7 0.0
4:29 PM 1.3 1.7 1.6 2.1 2.1 0.0
5:00 PM SINEMET (200mg)
5:14 PM 1.0 1.5 1.0 0.9 1.0 0.0
5:28 PM 0.3 0.6 0.3 0.8 2.4 0.0
6:01 PM 0.2 0.3 0.2 0.5 2.0 0.0
6:29 PM 0.0 0.0 0.2 0.8 1.7 0.0
6:59 PM 0.5 0.2 0.9 1.6 1.2 0.0
7:32 PM 1.3 0.9 1.6 2.1 1.0 0.0
8:03 PM SINEMET (200mg)
8:29 PM 0.8 0.6 0.5 0.7 0.5 0.0
9:01 PM 0.0 0.2 0.2 1.1 0.9 0.0
9:32 PM 0.0 0.1 0.9 1.6 1.3 0.0
9:55 PM 0.5 0.6 1.9 2.0 1.9 0.0
Mean 0.7 0.8 0.8 1.0 1.5 0.0
Fluctuation 0.7 0.7 0.7 0.7 0.5 0.0
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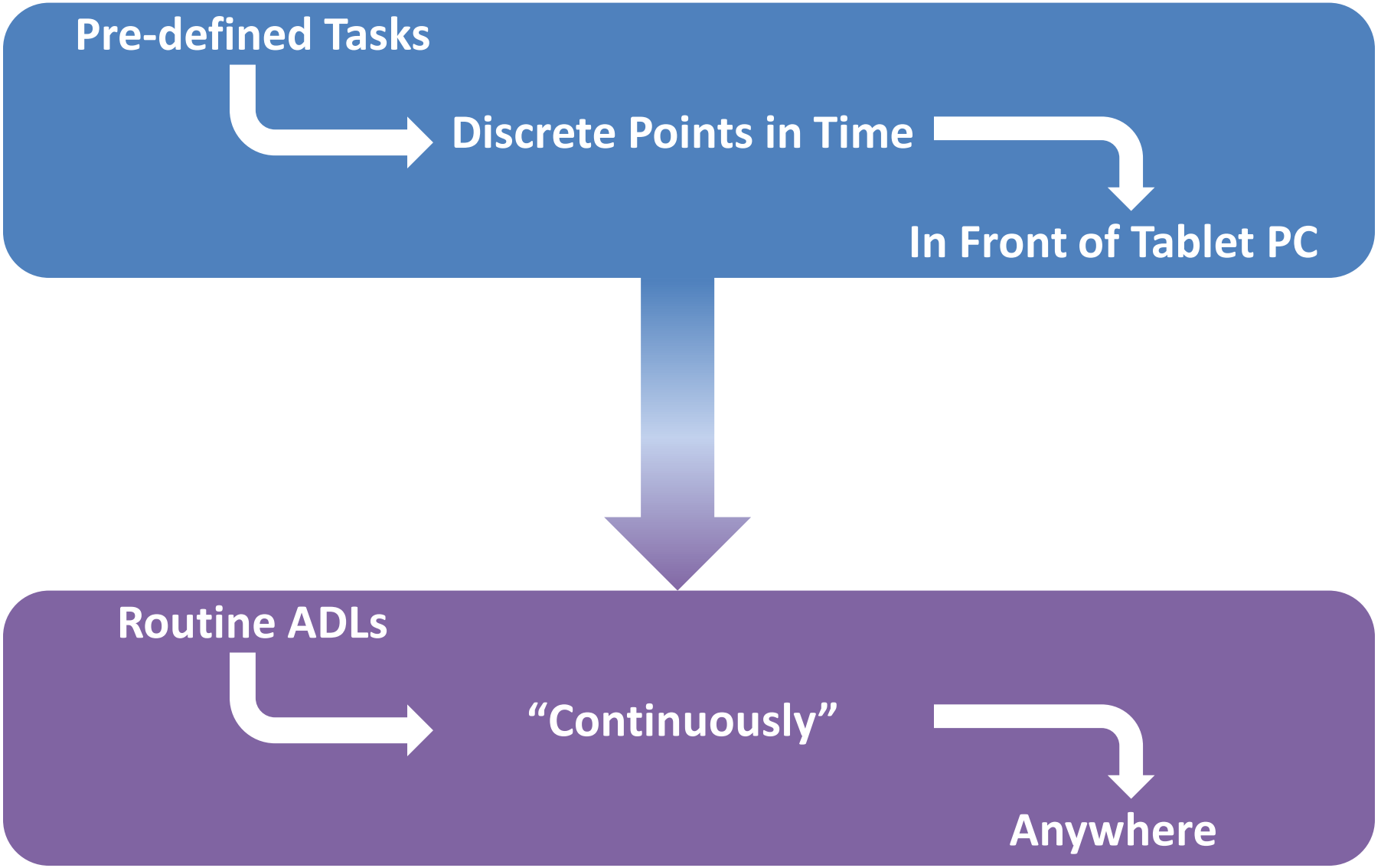

Reduce Patient Burden + Improve Compliance

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Challenges in Continuous Tremor Monitoring

Non-Standardized Motions

Movement Episodes of Variable Duration

Discerning Regular Activities from Symptoms

Tremor Assessment During Simulated ADLs

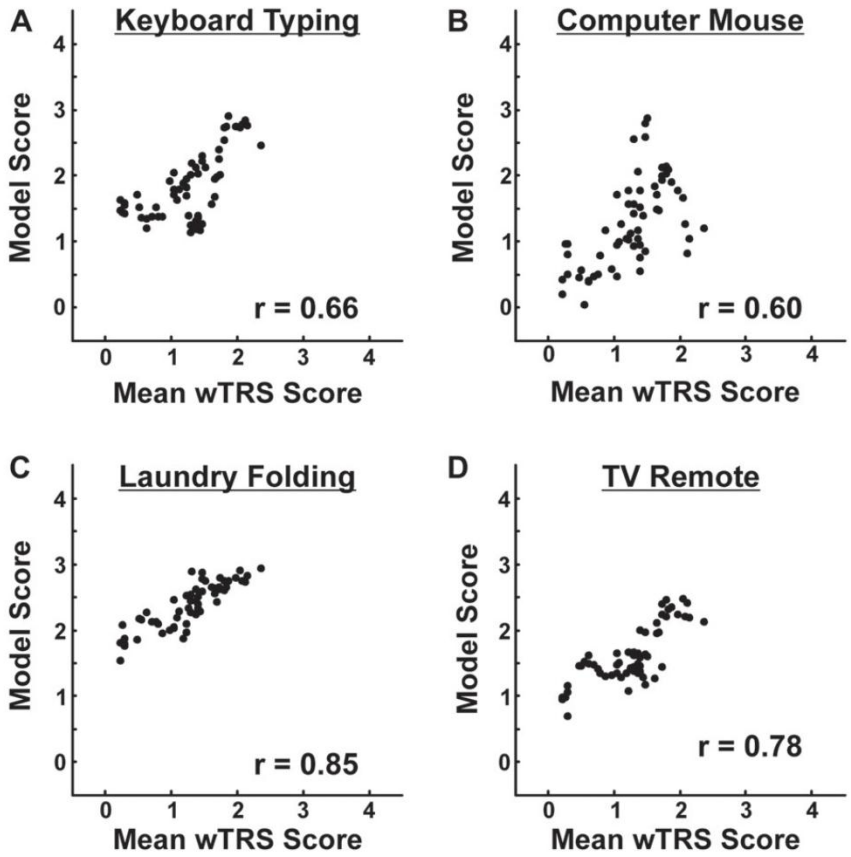
- 10 subjects with essential tremor wore motion sensors on the index finger in a laboratory
- Performed standardized tasks from the WHIGET tremor rating scale and non-standardized simulated ADL tasks
- Tremor rated by movement disorder specialists and by motion sensor system

Published

Heldman, DA; Jankovic, J; Vaillancourt, DE; Prodoehl, J; Elble, RK; Giuffrida, JP. Essential Tremor Quantification During Activities of Daily Living. *Parkinsonism and Related Disorders*. 2011.

Tremor Assessment During Simulated ADLs

- Mathematical models produced ADL task ratings that correlated well with recent clinician ratings of standardized tasks

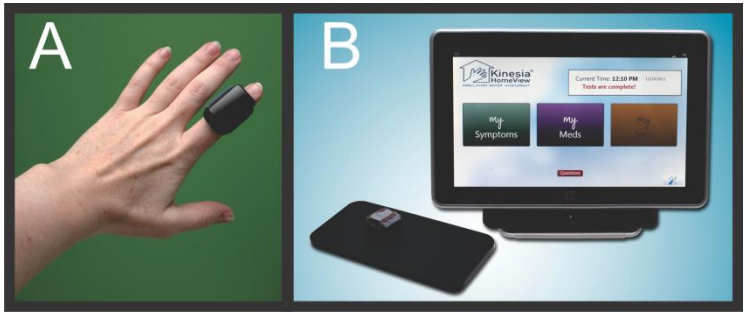


Published

Heldman, DA; Jankovic, J; Vaillancourt, DE; Prodoehl, J; Elble, RK; Giuffrida, JP. Essential Tremor Quantification During Activities of Daily Living. *Parkinsonism and Related Disorders*. 2011.

Continuous Tremor Assessment at Home

- 20 ET subjects wore the motion sensor for up to 10 hours per day on 2 separate days
- Completed standardized motion sensor tremor assessments at one-hour intervals to serve as checkpoints



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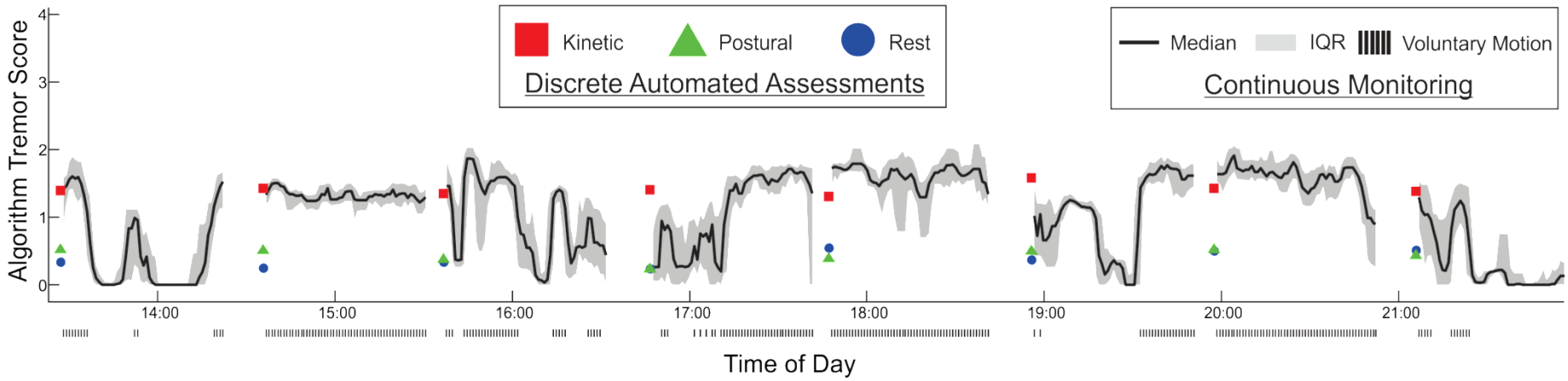
Christopher Goetz, MD
Sheila Eichenseer, MD

Continuous Tremor Assessment at Home



- Mathematical model uses processed motion sensor data to rate tremor amplitude severity every 12 seconds
- 5-minute sliding window used to filter the continuous scores

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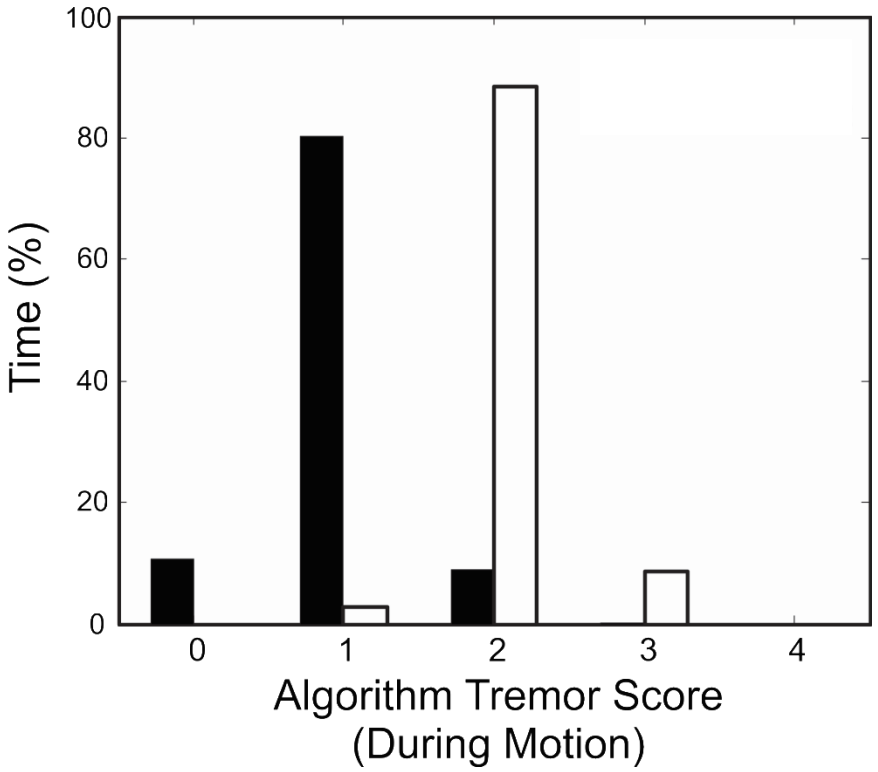
Continuous Tremor Assessment at Home

- Distribution of tremor scores is a quick tool for evaluating effectiveness of changes to therapy
- System can also be leveraged to monitor medication dose-response



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Conclusions

- Tremor can be accurately rated during activities of daily living performed in a laboratory setting
- Tremor can be rated on a continuous basis without prior knowledge of activity using a single finger-worn sensor in patients' homes
- Dyskinesia rating is in our pipeline and future work will evaluate continuous dyskinesia monitoring with an optimized sensor suite

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UF UNIVERSITY of FLORIDA

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