19 May 2018

Understanding balance and falls at the patient and group level in Parkinson's disease

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Health research throughout the lifespan

NIH K25HD086276

Georgia Tech

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EMORY UNIVERSITY

My background and trajectory as a translational researcher

Electrical Engineering/
Computer Science

Circuit design

Electrical Engineering/
Computer Science

Circuit design and simulation for brain implants

Electrical Engineering/
Computational Neuroscience

Simulating neuromechanical control of balance in animals

Clinical Research/
Basal Ganglia Neuroscience/
Movement Disorders

Understanding balance and falls in PD

Understanding balance and falls in PD is critical to informing new therapies

- **Falls are the main cause of accidental death** in individuals ≥ 65, and may indicate the beginning of serious decline.[1]
- **PD increases fall risk** (6 month risk ratio vs. matched healthy adults = 6.1 [2.5–15.1]).[2]
- **There are ways to reduce fall risk in PD.**[3,4]
- **Who will best benefit** is unclear,[5] and **we cannot send everyone**.[6]

[1]**Deandrea et al.,** *Epidemiol* 2010; [2]**Bloem et al.,** *J Neurol* 2001; [3]**Morris et al.** *NNR* 2015; [4]**Sparrow et al.** *JNPT* 2016; [5]**Allen et al.** *Mov Disord Clin Prac* 2015
[6]Medicare therapy cap: $1,980/year annually for physical and speech therapy combined: medicare.gov

There are many therapeutic options to prevent falls in PD

- Many studies use **secondary endpoints** thought to be precursors to falls such as behavioral scores (BBS, Mini-BESTest) or gait markers (speed or variability) largely for practical reasons.[1,2]

- **Some recent therapies reported to reduce fall rates:**

- In-person (but not remote) **progressive resistance training coupled with education**.[3,4]

- In-person "highly challenging" **individualized progressive balance training**.[5]

- **Tai Chi** (secondary outcome)[6]

- **Rivastigmine** (secondary outcome)[7]

[1]**McKay et al.** *J Neurol Phys Ther* 2016; [2]**Henderson EJ et al.** *Lancet Neurol* 2016
[3]**Morris et al.** *Neurorehabil Neural Repair* 2015; [4]**Morris et al.** *J Physiother* 2017
[5]**Sparrow et al.** *J Neurol Phys Ther* 2016; [6]**Li et al.** *N Engl J Med* 2012; [7]**Henderson EJ et al.** *Lancet Neurol* 2016

We do not know which patients should be referred to treatment

Movement Disorders
CLINICAL PRACTICE

RESEARCH ARTICLE

Predictors of Adherence to a Falls Prevention Exercise Program for People with Parkinson's Disease

Natalie E. Allen, PhD,[1,] Jooeun Song, PhD,[1] Serene S. Paul, PhD,[1,2] Catherine Sherrington, PhD,[2] Susan M. Murray, MHlthSci,[1] Sandra D. O'Rourke, BMedSc (Hons),[1] Stephen R. Lord, PhD,[3] Victor S.C. Fung, PhD,[4,5] Jacqueline C.T. Close, MD,[3,6] Kirsten Howard, PhD,[7,8] Colleen G. Canning, PhD[1]*

Abstract: Background: Long-term benefits of exercise for people with Parkinson's disease (PD) require regular and sustained participation. This study aimed to investigate predictors of adherence to a minimally supervised exercise program designed to reduce falls in people with PD.

Method: People with idiopathic PD who participated in the exercise arm of a randomized, controlled trial were included. Exercises were prescribed three times per week for 6 months. Adherence was defined as the percentage of prescribed sessions participants reported as having undertaken. Potential predictors of adherence included baseline measures of demographic variables, disease severity and duration, falls and fear of falling, pain, self-reported health and quality of life, cognition, physical activity levels, freezing of gait, functional mobility and balance, and knee extensor strength.

Results: The 108 participants included undertook a mean of 72% (standard deviation: 38%) of prescribed sessions. Participants had higher levels of adherence if they had shorter disease duration, less bodily pain, and better self-reported health and quality of life. A multivariate model (including disease duration, severity of bodily pain, self-reported physical well-being, the Frontal Assessment Battery, the Short Physical Performance Battery, and maximum walking time) explained 9% of the variance in exercise adherence, with shorter disease duration and less pain the strongest predictors (both predictors standardized $\beta = -0.2$; $P = 0.04$).

Conclusion: Disease duration and pain are likely to negatively influence exercise participation in people with PD. Given that most of the variance in adherence is unexplained, further work is required to determine other predictors of adherence to long-term exercise programs.

RESEARCH ARTICLE

Economic Evaluation of a Falls Prevention Exercise Program Among People With Parkinson's Disease

Inez Farag, PhD,[1*] Catherine Sherrington, PhD,[1] Alison Hayes, PhD,[2] Colleen G. Canning, PhD,[3] Stephen R. Lord, PhD,[4] Jacqueline C.T. Close, MD, PhD,[4,5] Victor S.C. Fung, MD, PhD,[6] and Kirsten Howard, PhD[2,7]

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[6]*Movement Disorders Unit, Department of Neurology, Westmead Hospital, and Sydney Medical School, The University of Sydney, Sydney, Australia*
[7]*Institute for Choice, University of South Australia, North Sydney, Australia*

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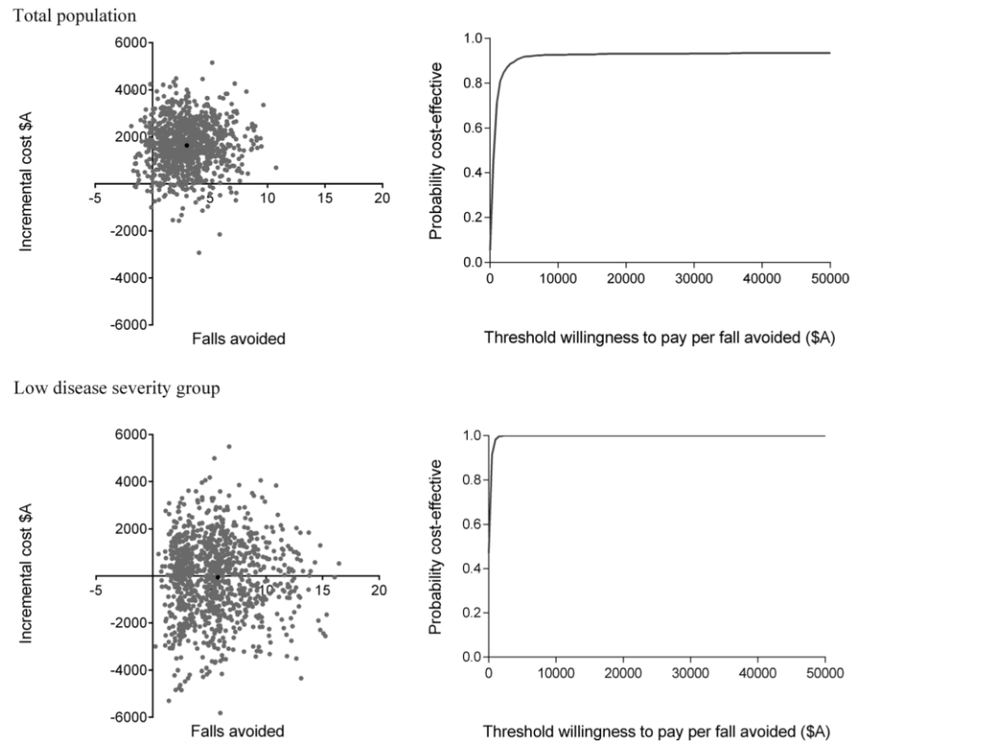
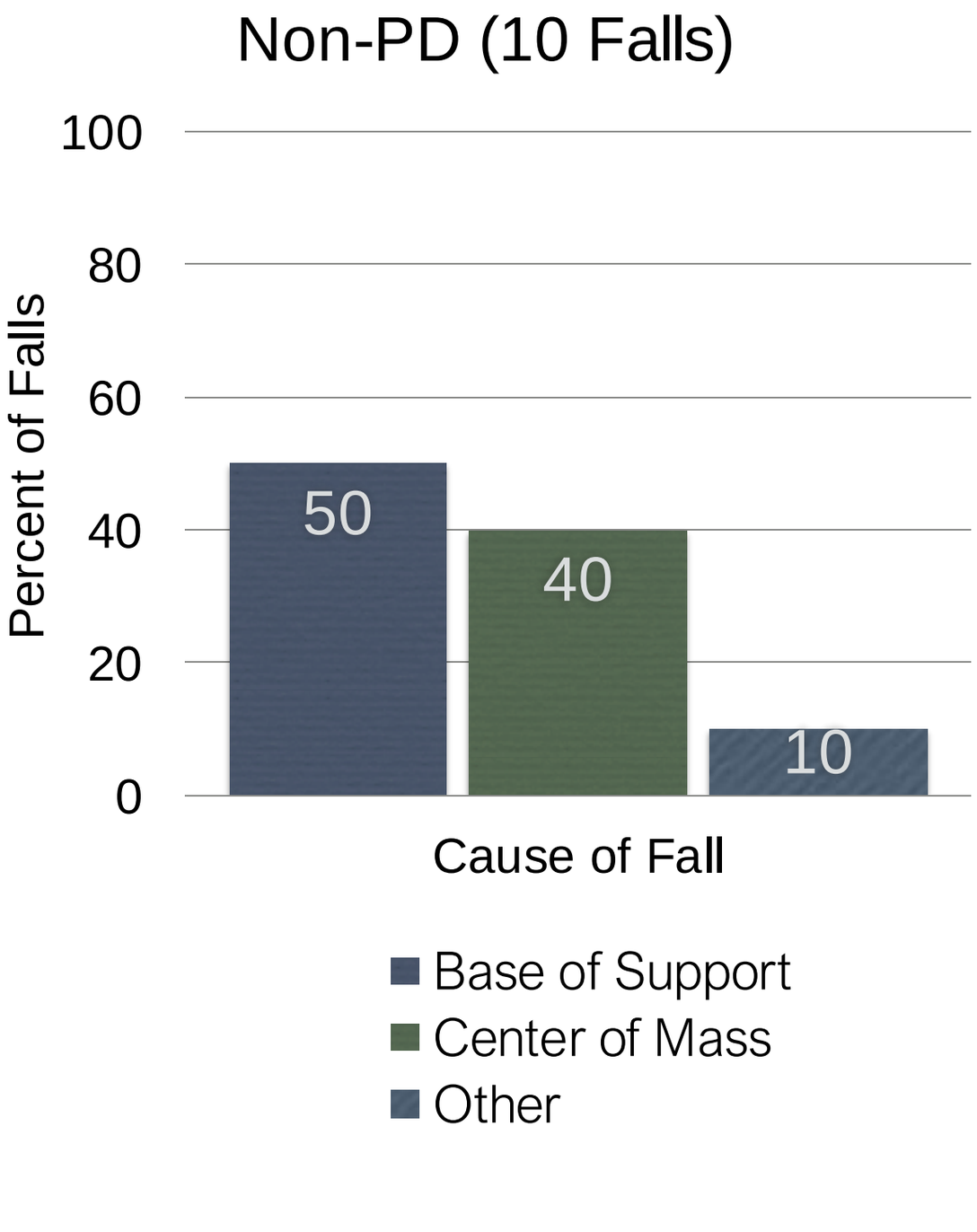
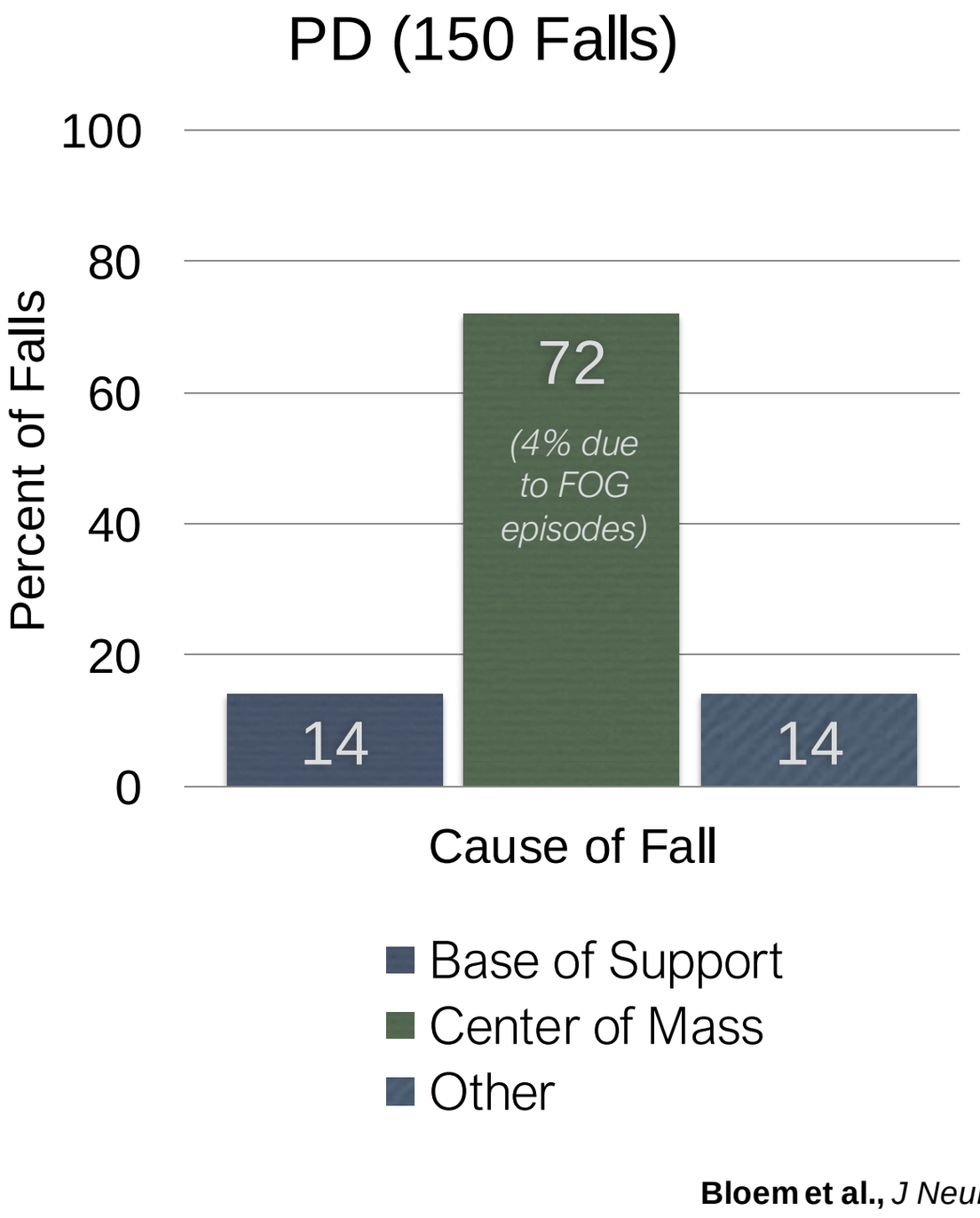


FIG. 1. Incremental cost-effectiveness ratio per fall avoided for point estimate (black circle) and 1,000 bootstrapped cost-effect pairs (gray circles).

PD falls predominantly result from inability to control the Center of Mass (CoM)



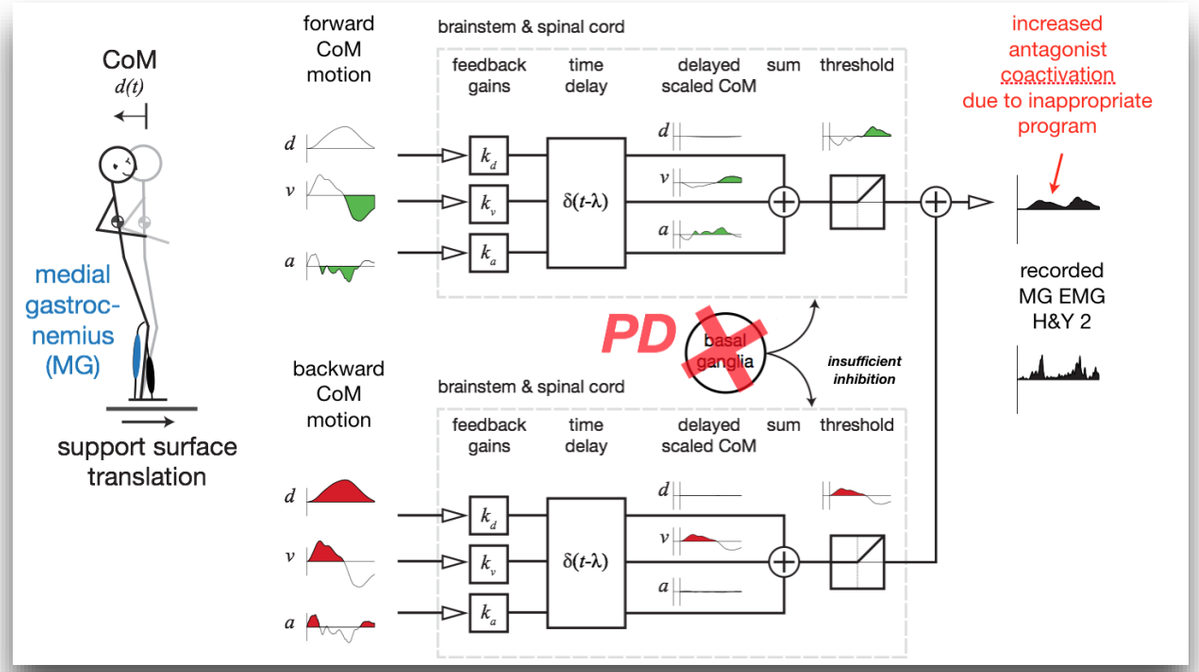


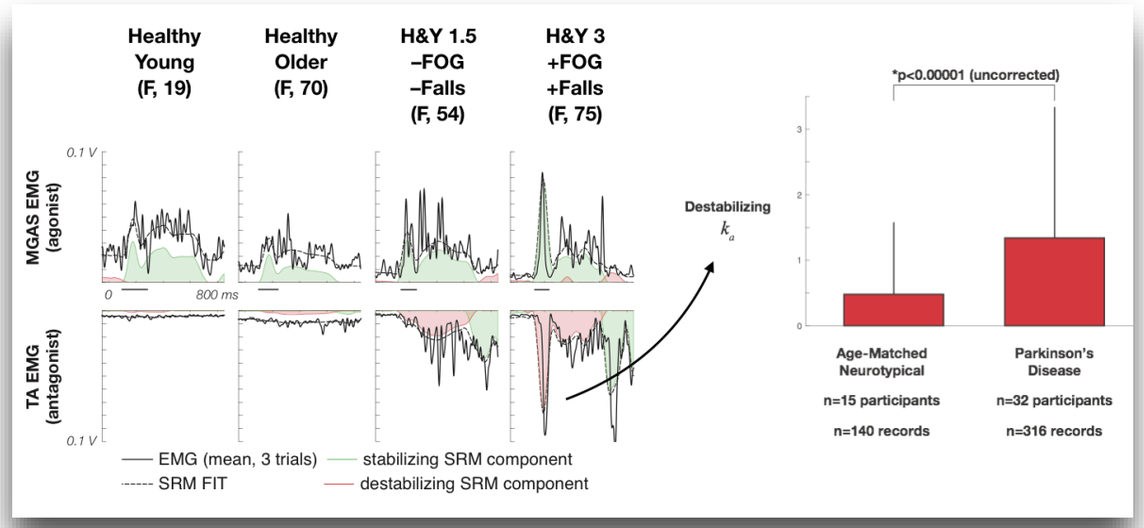
Bloem et al., *J Neurol* 2001

I use a perturbation platform to precisely affect the CoM and muscle responses

McKay et al., *JNPT* 2016

I use computational approaches at the patient level to “reverse engineer” balance in individual patients

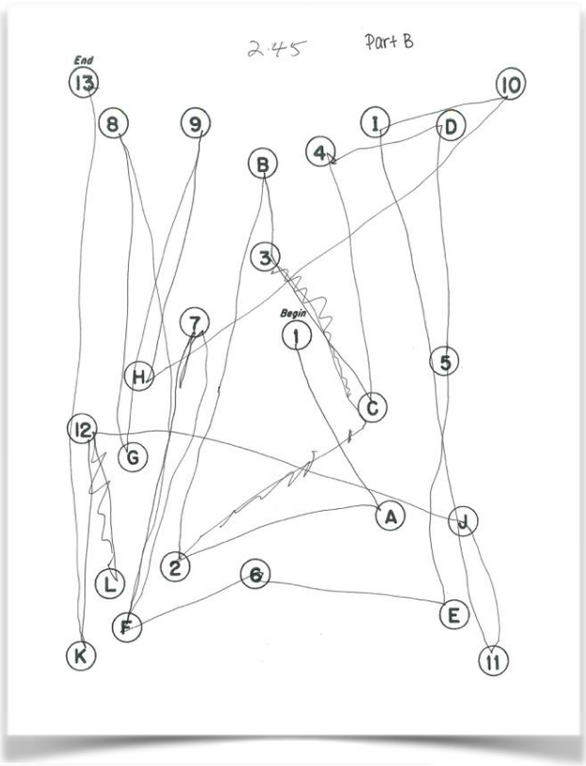




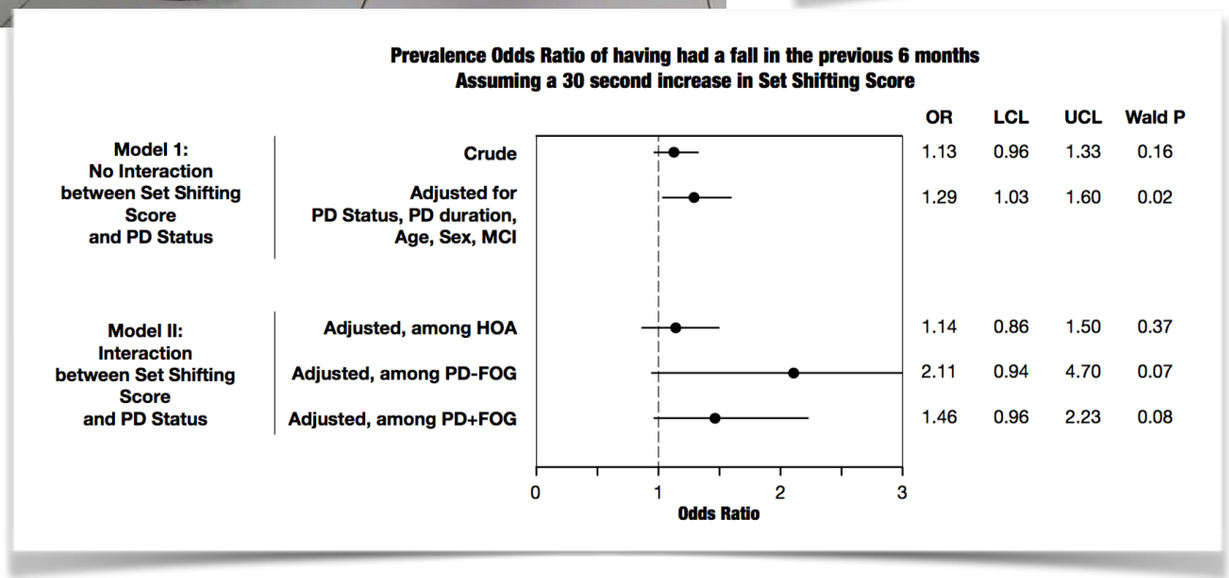
- Simulations to infer activity of motor neurons, brainstem circuits, evaluate biological hypotheses in real patients
- Independent variables: medications, DBS, rehabilitation, training
- Outcomes: better predictions of fall risk, knowledge about how falls happen

McKay et al., *JNPT* 2016; Allen, **McKay** et al., *J Neurophysiol* 2017; **McKay** et al., *in prep*

I combine these with epidemiological approaches at the group level to understand fall risk



- Cognitive, demographic, clinical covariates critical to understanding fall risk
- Large N required to account for patient variability
- Current study tracking N=100 patients for 12 months



McKay et al., *Gait Posture* 2018

Thank you!

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