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

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My background and trajectory as a translational researcher

Electrical Engineering/Computer Science
Circuit design

Electrical Engineering/Computational Neuroscience
Simulating neuromechanical control of balance in animals

Clinical Research/Basal Ganglia Neuroscience/Movement Disorders
Understanding balance and falls in PD

Electrical Engineering/Computer Science
Circuit design and simulation for brain implants
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.\(^6\)

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\(^1\)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](http://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

We do not know which patients should be referred to treatment
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.
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., JNPT2016; Allen, McKay et al., J Neurophysiol2017; 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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