Development of a method to identify fall-prone individuals in the population of Parkinson Disease patients using measures of dynamic stability

INTRODUCTION

>> The purpose: Use kinematics data from Activities of Daily Life (ADLs) to develop a method to differentiate between fall-prone and non-fall-prone people among Parkinson Disease (PD) patients.

>> Falls are the most common cause of injury-induced death and injury-related hospitalization in the elderly (65 years and older) population.

>> Falls are the second most common cause of hospitalization in Parkinson Disease patients.

>> Falls can cause fractures, abrasions, cuts and soft tissue damage, reduced fitness, social isolation and psychological trauma, increasing the risk of mortality and morbidity.

>> Falls not only affect the patient but also are a huge burden on health care costs.

>> This study is targeted at developing an easy and practical method to identify people with higher risk of falling.

HYPOTHESIS

Maximum Lyapunov Exponent (MLE) will be significantly higher for PD patients with a history of falls (more than 2 falls per year) than PD patients without history of falls.

BACKGROUND

Falls and fall-related injuries: huge problem

In 2008, emergency departments in US treated 2.1 million fall injuries among older adults.

In 2000, the total direct medical costs of all fall injuries for people 65 years and older exceeded $19 billion.

By 2020, the annual direct and indirect cost of fall injuries is expected to reach $54.9 billion (in 2007 dollars).

Current method to identify "fallers" is not good enough

Current method: History of falls :-> A person would have to be already falling to be classified as a "faller". TOO LATE !!!

We need a method that is independent of history of falls and is more sensitive.

BACKGROUND

Problems with history of falls

Prone to recall bias, even if the history is taken from medical records. Can be collected prospectively.

Not sensitive enough.

Does not answer: Why and when are people falling ???

Method proposed in this study

Use measures of dynamic balance along with measures of static balance.

Use methods of non-linear analysis of time series data to assess balance.
We used Maximum Lyapunov Exponent (MLE).

MLE would be used in conjunction with traditional measures of static balance to identify fallers.

BACKGROUND

Maximum Lyapunov Exponent

MLE is extensively used in analysis of dynamic systems.

It is a measure of chaos in a system. Larger (+ve) MLE => more chaotic system.

MLE has been used to assess gait in human subjects.

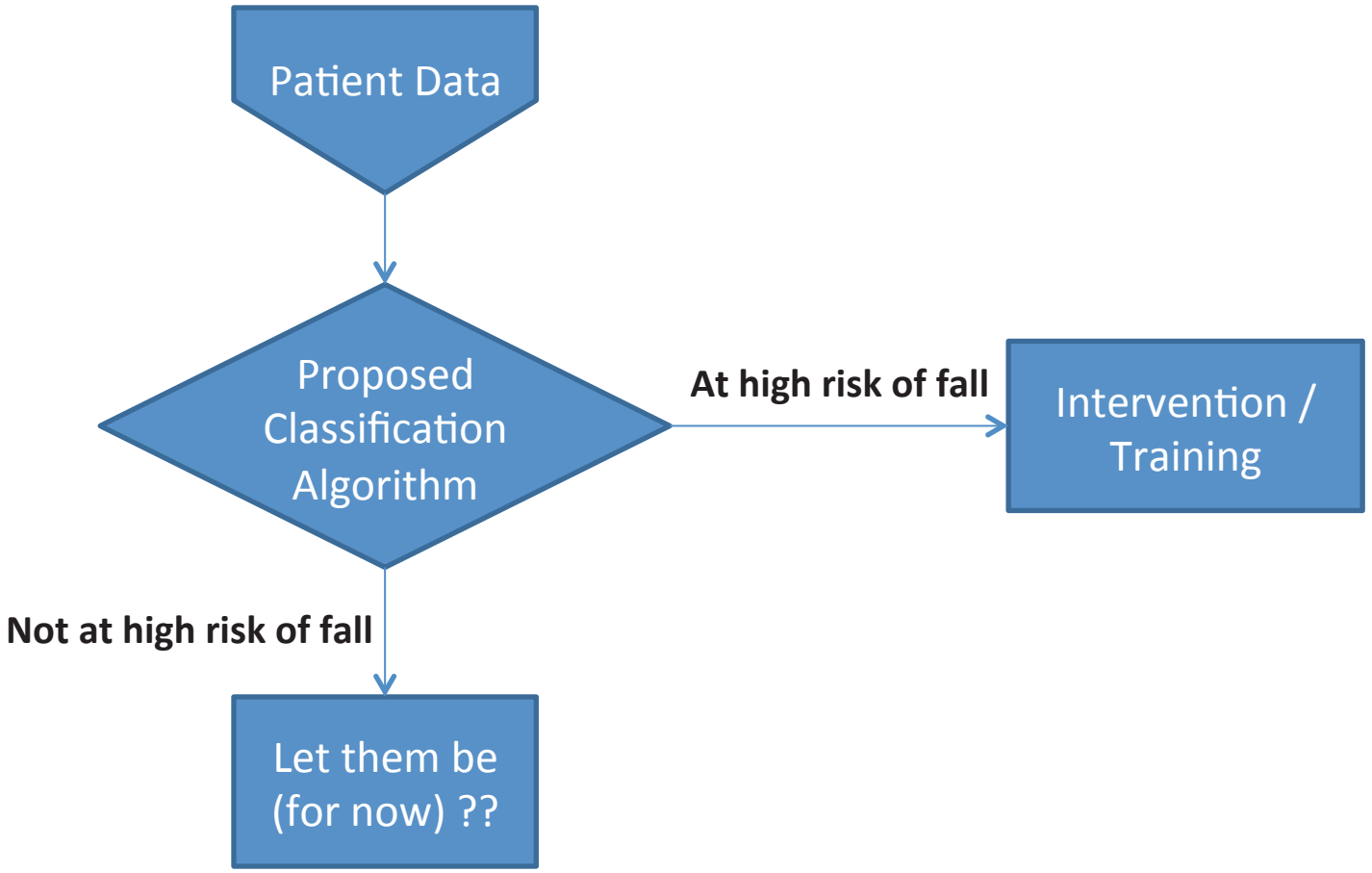
How will this method help

We can identify people with higher risk of falling ***BEFORE*** they start falling.

Once we have identified “fall-prone” people, we can devise appropriate inventions (e.g. symptom specific exercise trainings etc.) for these people. This will reduce their risk of falling, reduce injuries and also reduce medical cost.

USE/ APPLICATION

>> The proposed method is meant to serve as a screening tool



IMPLICATIONS

>> Reduce the number of fall-related injuries.

>> Reduce the money spent on treatment and rehabilitation.

>> Improve quality of life.

STUDY DESIGN

Cross-sectional design

Sample size = 45 : 15 Parkinson Disease (PD) fallers
15 PD non-fallers
15 Controls

METHODS

The following data were collected on all subjects:

Questionnaire: History of falls and freezing of gait; Health history questionnaire

UPDRS (Unified Parkinson Disease Rating Scale): Collected for Parkinson Patients.

Static Postural Balance: Sway area and sway length. Measured using force platform. Balance was measured under four different conditions:

- Eyes open on firm surface
- Eyes Closed on firm surface
- Eyes open on 4 inch foam
- Eyes closed on 4 inch foam

METHODS

Gait Parameters: Gait was measured using GAITRite mat (GAITRite, CIR Systems, Inc., Havertown, PA). The outcomes measures obtained from the mat were:

- Gait velocity
- Cadence
- Stride Velocity

TUG (Timed Up and Go Test): Time taken to get out of a chair, walk 10 feet, turn around, come back and sit in the chair.

METHODS

Kinematics of Center of Mass: Measured while the subjects performed the following Activities of Daily Life (ADLs):

- Getting out of an arm chair
- Getting out of a chair without arms
- Getting off a toilet seat
- Getting off a stool
- Getting out of a bed (from sitting position)
- Rolling from supine position to sideways in bed
- Getting from supine position to sitting in bed
- Walking straight for 20 feet.

Kinematics of COM was also captured during the TUG test.

RESULTS

So far, we have collected data on 4 subjects: 3 Parkinson Disease (PD) patients (2 fallers and 1 non-faller) and 1 control.

We are planning to complete data collection by December, 2012.

	PD Fallers (n=2)	PD Non-Fallers (n=1)	Control (n=1)
Age	68.5	51	63
Falls last year	5	0	1
UPDRS	28.5	24.5	NA

Maximum Lyapunov Exponent (MLE)

	PD Fallers (n=2)	PD Non-Fallers (n=1)	Control (n=1)
MLE	1.05	0.52	0.72

RESULTS

STATIC POSTURAL BALANCE

	SWAY TEST CONDITION	PD FALLERS	PD NON FALLERS	CONTROLS
SWAY LENGTH (cm)	Eyes open, firm surface	52.86	17.34	28.84
	Eyes closed, firm surface	72.26	25.72	37.22
	Eyes open, foam	84.84	24.08	56.34
	Eyes closed, foam	144.99	41.17	102.34
SWAY AREA (sq. cm)	Eyes open, firm surface	3.46	1.19	1.60
	Eyes closed, firm surface	3.68	2.30	1.95
	Eyes open, foam	4.17	2.03	3.39
	Eyes closed, foam	9.51	3.09	6.29

TIMED UP AND GO TEST (TUG)

	PD FALLERS	PD NON FALLERS	CONTROLS
TUG time (sec)	14.82	6.61	8.53

RESULTS

GAIT PARAMETERS

	PD Fallers (n=2)	PD Non-Fallers (n=1)	Control (n=1)
Gait Velocity (cm/s)	97.83	119.15	148.2
Cadence (steps/min)	101.45	108.97	131.9
Stride Velocity (cm/s)	97.74	119.64	149.97

CONCLUSION

All available results are in the expected direction.

Gait velocity, cadence and stride velocity: lower for fallers.
Sway parameters, MLE and TUG time: higher for fallers.

More concrete conclusions can be drawn once we have collected all the data and have compared the groups statistically.

LIMITATIONS

>> To test our hypothesis, we collected history of falls retrospectively

>> Data was collected during tasks simulated in lab, not performed in daily life.

>> We assumed that motion of center of mass of the body would represent the motion of whole body. A better approach would be to treat body as made of link segments and measure motion of each link segments.
However, this would lessen the practicality of the method in a clinical setting.

>> It was a cross-sectional study.

FUTURE WORK

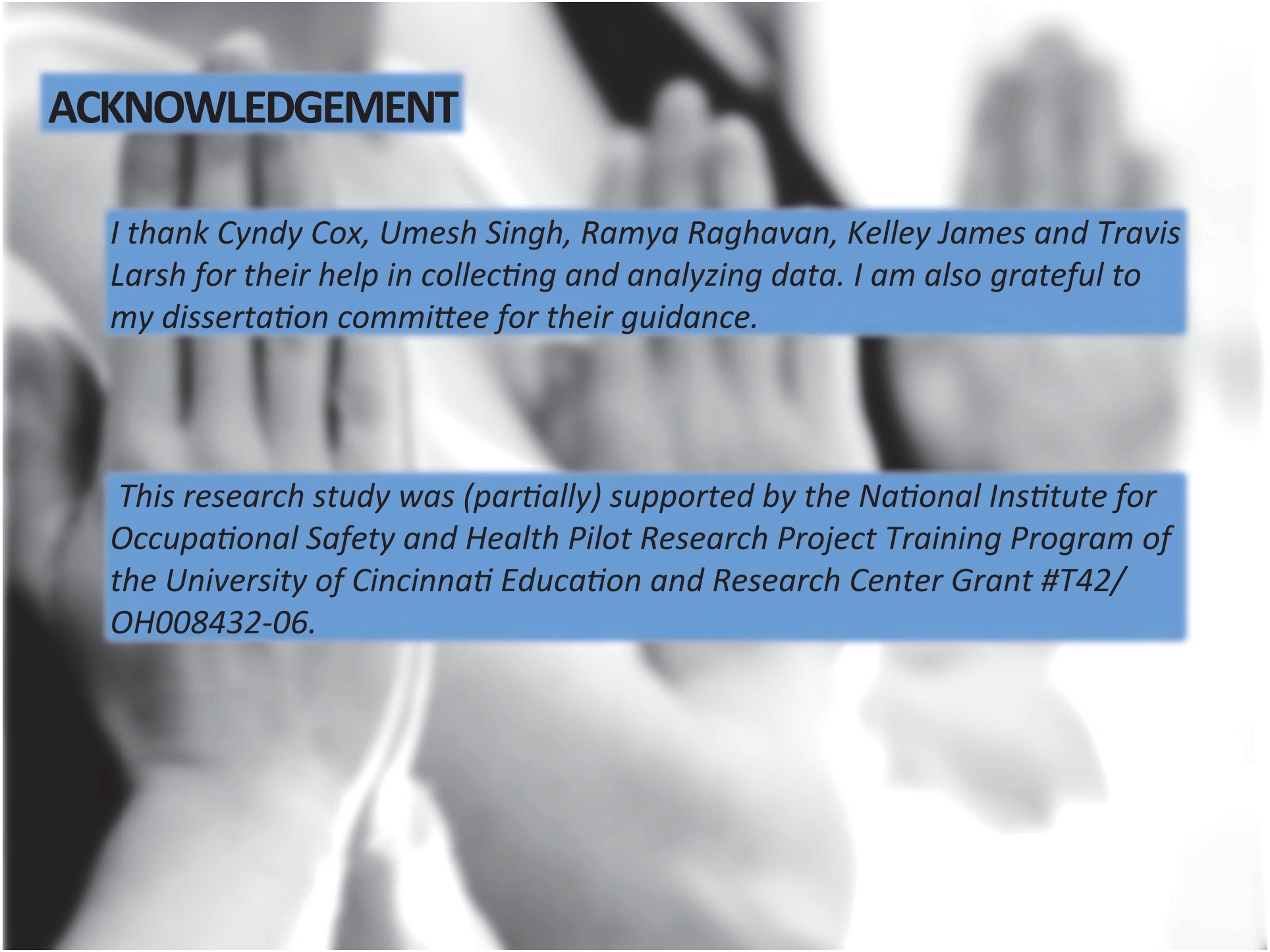
>> Formulate a classification matrix, using parameters measured in the study, to categorize people as fall-prone or non-fall prone. (this will be done once the data collection is complete)

>> Have subjects wear portable wireless sensors at home so that we get more realistic data and not just from simulation.

>> Collect history of fall data prospectively to validate our method.

>> Identify exact mechanism through which individuals are falling so that specific interventions can be devised.

>> Measure data in population other that PD patients to see if the method is applicable for general population



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Pilot Research Project Symposium
October 4-5, 2012

Thursday, October 4, 2012

Presenter	Presentation Title
Michael Sliter, PhD Psychology Bowling Green State University	"Effects of Coping Strategies on Chronic and Traumatic Stress Experience at Work" (PowerPoint)
Brian Kim for Srikara Peelukhana School of Dynamic Systems University of Cincinnati	"Vibration-Frequency Induced Changes in the Bone Tissue Morphology"
Ahmed Elgafy, PhD School of Dynamic Systems University of Cincinnati	"Merits of Employing Carbon Foam Fabrics in Firefighter's Helmet Shell" (PowerPoint)
Tiffany Poole Wilson Environmental Health University of Cincinnati	"Documenting Amount of Manual Lifting Performed by Nurses in a Hospital Setting" (PowerPoint)
Max Stevenson for Yuet-Kin Leung, PhD Environmental Health University of Cincinnati	"Endocrine Disruptor Exposure in Firefighters" (PowerPoint)

Friday, October 5, 2012

Presenter	Presentation Title
Katherine Sliter, PhD Psychology Bowling Green State University	"Developing a Method to Assess Organizational Climate for Healthy Weight" (PowerPoint)
Ashutosh Mani Environmental Health University of Cincinnati	"Development of a Method to Classify Fall-prone Individuals in the Population of Parkinson Disease Patients Using Measures of Dynamic Stability" (PowerPoint)
Yingzi Liu for Linda H. Nie, PhD Health Sciences Purdue University	"Design of Novel In Vivo Neutron Activation Analysis System for Noninvasive Quantification of Mn in Bone with Monte Carlo Simulations" (PowerPoint)
Alexander Sergeev, MD, PhD, MPH Social and Public Health	"Comparative Effectiveness of Cardiovascular Procedures in Pneumoconiosis Patients" (PowerPoint)

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Main Menu

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