Wearable Sensors for Quantitative Motor Assessments in Multiple System Atrophy

Daniel O. Claassen[1], Jessica Iregui[1], Amy Wynn[1], Charles S. Davis[2], Cynthia Wong[3], and David Stamler[3]
[1] Vanderbilt University Medical Center, Nashville, TN, [2] CSD Biostatistics, Oro Valley, AZ [3] Alterity Therapeutics, Newark, CA

OBJECTIVE

- To determine the utility of quantitative wearable sensors in multiple system atrophy (MSA).

INTRODUCTION

- MSA is a rapidly progressive parkinsonian disorder that variably presents with parkinsonism, ataxia, and autonomic impairment.
- Motor impairment results from Parkinsonism and ataxia, contributes to gait disturbance and falls, and reduces quality of life in MSA.
- Wearable sensors have potential to characterize motor disability in an outpatient setting and to serve as clinical trial outcomes.
- PAMSys is a validated wearable movement sensor for continuous monitoring of gait and activity parameters

METHODS

- Participants enrolled in biomarkers of progression in MSA (bioMUSE) were diagnosed with early MSA (<3 years of motor symptoms) by clinical assessment.
- All had neurologic exam, neuroimaging and fluid biomarkers.
- The motor exam of the Unified MSA Rating Scale[1] (UMSARS II), Parkinson Plus Scale (PPS), Tandem Walk (TW) and Timed Up and Go were completed at Baseline (BL) and every 3 months through 12 months.
- PAMSys actigraphy sensors were worn continuously for up to 12-months, allowing assessment of gait parameters (step count, bouts [episodes] of walking, steps per bout, cadence/variability), postures (minutes of sitting, lying, standing, or walking) and postural transitions (sit-to-stand).
- Clinical assessments were obtained at BL and months 3, 6, 9 and 12. At each time point, sensor parameters were obtained by averaging data over 14-day epochs.
- Pearson correlation coefficients between each clinical variable and each sensor variable were estimated at each time point. The two-sided p-value from the test of the null hypothesis that the true correlation equals zero was computed.

RESULTS

Baseline Demographic and Clinical Data

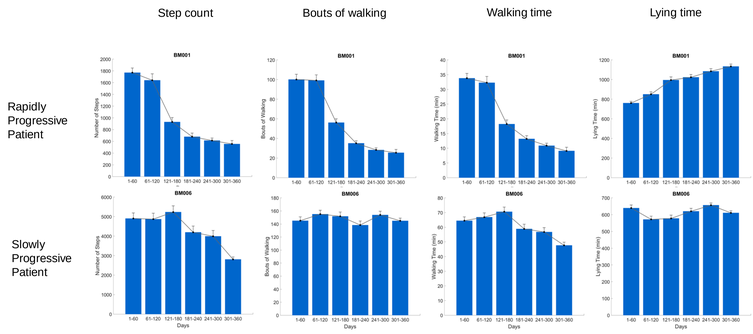
N	17
Sex (M/F)	9/8
Age (years), mean	62.1
UMSARS II score (baseline), mean	14.3
PPS Motor score (baseline), mean	33.0

[1] Wenning et al. Development and Validation of the UMSARS. Mov Disord 2004. DOI: 10.1002/mds.20255
[2] Payan CA et al. Disease severity and progression in PSP and MSA: Validation of the NNIPPS-Parkinson Plus Scale. PLoS One. 2011;6(8):e22293.

RESULTS

- There was a strong relationship between sensor parameters and motor assessments
- Daily step count strongly correlated ($|r| > 0.6$) with UMSARS II and PPS Motor scores at months 6, 9, and 12, indicating that greater motor impairment was correlated with fewer steps.
- Bouts of walking strongly correlated ($|r| > 0.7$) with UMSARS II and PPS Motor scores at months 6, 9, and 12, indicating that greater motor impairment was correlated with fewer bouts of walking.
- Time spent lying strongly correlated ($r > 0.6$) with UMSARS II at 3, 6 and 9 months and PPS Motor score at months 6, 9, and 12.
- We created a "mobility ratio" which assessed the ratio of active movement (standing plus walking) to immobility (sitting plus lying). This ratio strongly correlated ($|r| > 0.7$) with UMSARS II and PPS Motor scores at months 9 and 12.
- Timed Up and Go assessments were strongly correlated ($|r| > 0.7$) with total number of steps, bouts of walking, minutes walking, minutes of standing and minutes of lying at months 6, 9, and 12.
- Tandem Walk assessments were correlated with total number of steps, bouts of walking and minutes walking ($|r| > 0.5$) across months 3, 6, 9, and 12.
- Figure 1 depicts change in wearable sensor parameters over 12 months for a rapidly progressive and slowly progressive patient. Note the decline in the slowly progressive patient between 6 and 12 months in step count and walking time.

Figure 1: 60-day average data over 12 months



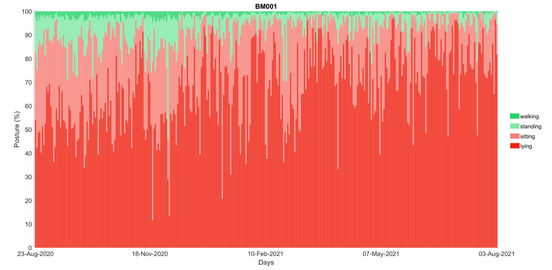
Data represent the moving average from baseline to one year follow-up.

Clinical data (UMSARS II, PPS Motor scores) were obtained at BL at 3, 6, 9 and 12 months
Rapidly progressive patient: UMSARS II : 27, 26, 25, 27, 31; PPS: 23, 66, 68, 70, 84
Slowly progressive patient: UMSARS II : 13, 19, 19, 19, 20; PPS: 35, 43, 45, 44, 50

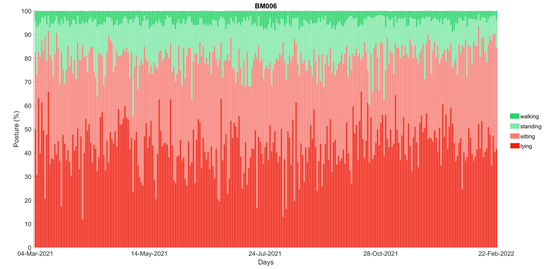
RESULTS

Figure 2: Posture plots present %time with active movement (walking/standing: green) or immobility (sitting/lying: red) in rapidly and slowly progressive patients over 12 months

Rapidly Progressive Patient



Slowly Progressive Patient



CONCLUSIONS

- Sensor parameters correlate strongly with clinical scales of motor impairment and are largely driven by changes in gait stability
- The Timed Up and Go, which reliably quantifies functional mobility, strongly correlated with several gait parameters suggesting their clinical relevance in assessing MSA
- Step count and walking time are sensitive measures of disease progression in early MSA
- Novel quantitative motor measures provide important clinical data in MSA patients that is not captured by neurological examination
- These results will inform future trials in MSA as potential outcome measures for disease modifying therapies

American Academy of Neurology. April 22-27, 2023. Abstract No. 4205