

# Smartphone software for home monitoring of motor symptoms in Parkinson's disease: The CloudUPDRS Smartphone Software in Parkinson's (CUSSP) study

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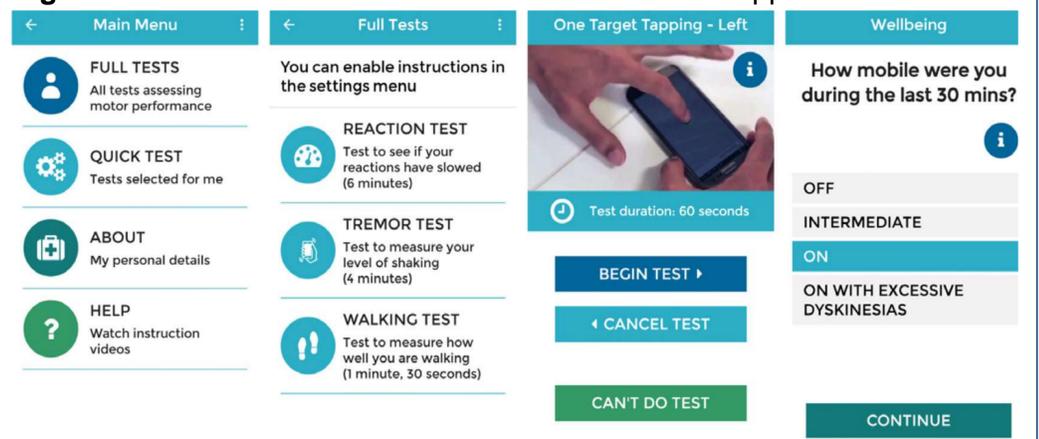
## BACKGROUND AND OBJECTIVE

- The most common framework to assess motor severity in Parkinson's disease (PD) is the **MDS-Unified Parkinson's Disease Rating Scale (UPDRS) part III**<sup>1</sup>.
- MDS-UPDRS is limited by inter-rater variability, the clinical effort required and score variability due to day-to-day motor fluctuations.
- Although a number of alternative digital monitoring measures exist, these lack clinical interpretability and robust clinical evaluation.
- We previously developed **cloudUPDRS**, the first smartphone app to achieve certification as a Class I Medical Device and published a proof-of-principle clinical study<sup>2</sup>.
- The **CUSSP study** is a pre-registered (NCT02937324) dual-site, part-blinded and cross-over randomised study.
- Primary endpoint:** accuracy with which the cloudUPDRS smartphone derived metrics can predict subsets of MDS-UPDRS part III score.

## PATIENTS AND METHODS

- Patients were recruited from two UK Hospitals. Each patient underwent a video-recorded MDS-UPDRS part III examination, and a smartphone-based assessment, the order of which was randomised by the software.
- Three neurologists separately rated the videoed examination of each MDS-UPDRS part III subcomponent, blinded to patient's medication state and test order.
- Smartphone subtests were designed to mimic the MDS-UPDRS as far as possible, by means of three types of subtest: 1) bradykinesia in 4 limbs, 2) tremor in 4 limbs, and 3) walking.

**Fig. 1.** Views of the user interface of the cloudUPDRS app.

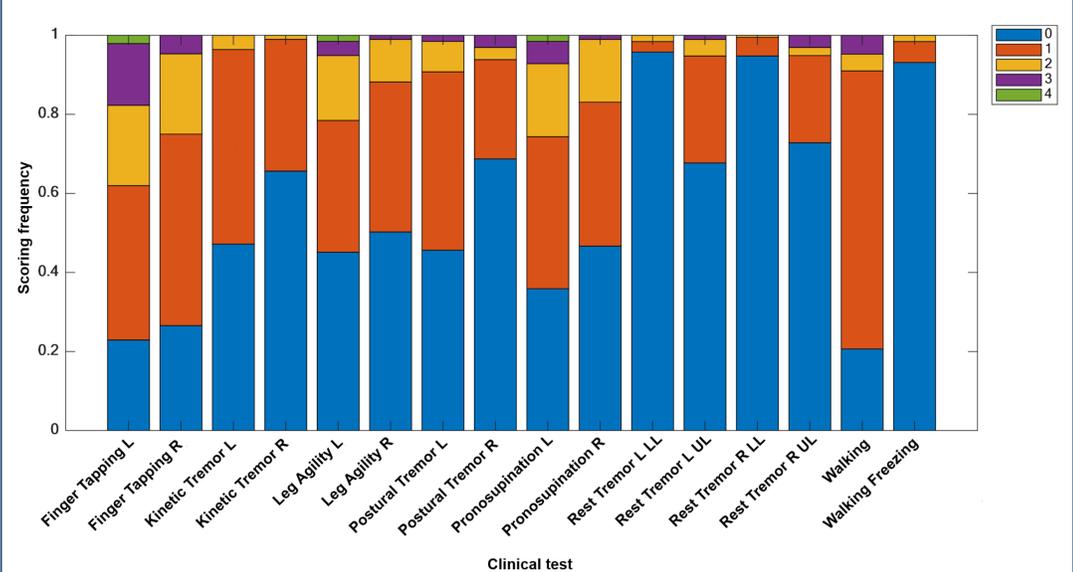


## RESULTS

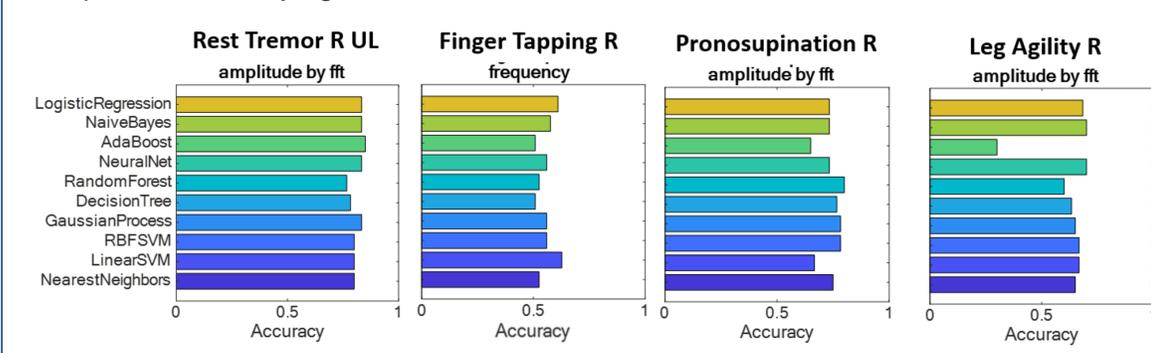
- Sixty-two patients were recruited:

	Median	Range	
		5 <sup>th</sup> percentile	95 <sup>th</sup> percentile
Age (years)	68	51.6	80
Disease Duration (years)	5	1	17
Levodopa Equivalent Dose (mg/day)	452	100	1345.6
Montreal Cognitive Assessment (range, 0-30)	27	21.55	30
Beck Depression Inventory (range, 0-63)	9	1.55	25.8
PDQ-39 (range, 0-100)	32	6.55	77.9
Hoehn & Yahr (range, 1-5)	2	2	2
MDS UPDRS part III (range, 0-132)	31.5	10.2	50.8

**Fig. 2.** Clinical scoring frequency of the three blinded raters for each subcomponent of the MDS-UPDRS part III.



**Fig. 3.** Cross-validated prediction accuracy compared to clinical raters of four smartphone tests relying on one feature each.



## CONCLUSIONS

- CloudUPDRS is a scalable certified system that has the potential to provide objective high-frequency motor assessment of individuals with PD.
- Through different machine-learning approaches, we found good correspondence between smartphone measures and subcomponents of the MDS-UPDRS part III.

### References

- Goetz CG, *et al.* Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS): scale presentation and clinimetric testing results. *Movement disorders: official journal of the Movement Disorder Society* 2008; 23(15): 2129-70.
- Kassavetis P, *et al.* Developing a Tool for Remote Digital Assessment of Parkinson's Disease. *Movement disorders clinical practice* 2015; 3(1): 59-64.