Supplemental Online Content

Duffley G, Lutz BJ, Szabo A, et al. Home health management of Parkinson disease deep brain stimulation: a randomized clinical trial. *JAMA Neurol*. Published online June 28, 2021. doi:10.1001/jamaneurol.2021.1910

This supplemental material has been provided by the authors to give readers additional information about their work.

eMethods

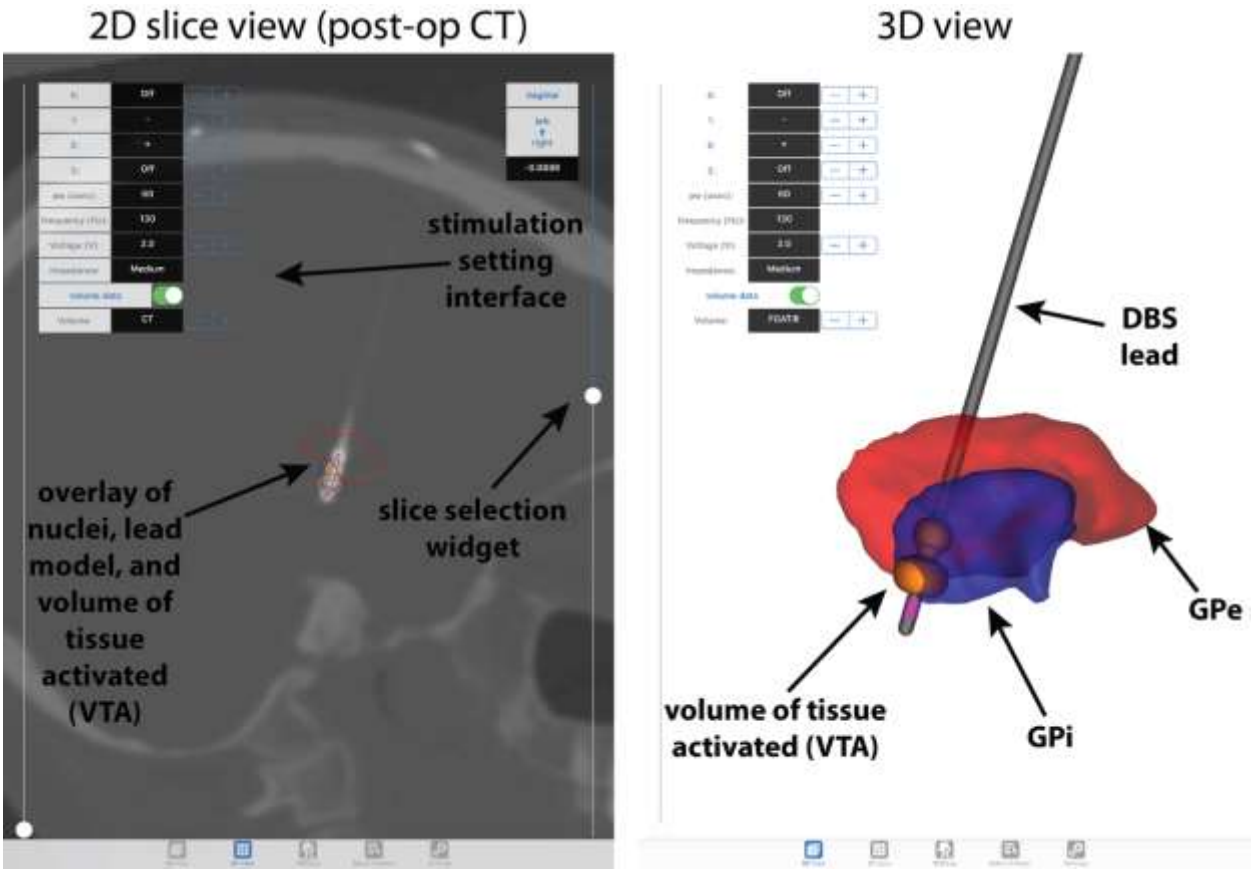
MAP DBS

The Mobile Application for PD DBS (MAP DBS) is a DBS programming mobile decision support system that provides interactive, patient-specific computational models of DBS therapy. Each model consists of four primary pieces of information: pre and postoperative medical imaging (MRI, CT), the location of the DBS lead(s), a segmentation of the target nuclei (subthalamic nucleus or globus pallidus internus), and the volume of tissue activated (VTA) for a range of DBS settings. MAP DBS models were generated at the Scientific Computing and Imaging (SCI) Institute and delivered to the programming clinician for use in ImageVis3D Mobile, a free iOS app. Models were delivered prior to each patient's first DBS programming session.

MAP DBS models were generated using at least one preoperative whole head MRI and one postoperative head CT or MRI from each patient. Advanced Normalization Toolkit (ANTs) rigid image registration was used to align all preoperative and postoperative image volumes to the preoperative T1. [1] DBS lead location(s) were identified by the metal artifact in postoperative imaging and aligned using SCIRun 4 (http://www.sci.utah.edu/cibc-software/scirun.html). Patient specific segmentations of the DBS target nuclei were obtained with segmentations from the Montreal Neurological Institute PD25 template via nonlinear transforms returned by running antsRegistration SyN algorithm [2] between the PD25 template and the preoperative T1 MRI.

Computational models of the VTAs were precomputed for a range of settings for the Medtronic DBS lead using the axon model method detailed in our previous publications.[3,4] Briefly, finite element method simulations were used to calculate voltage solutions for each DBS setting. The voltage solutions were mapped onto a regular 3D grid of cable equation axon models that surrounded the lead. Simulations were run using NEURON [5] to identify the extent of neuronal activation caused by each stimulation setting. The area of activation is represented by the isosurface of all activated neuron models.

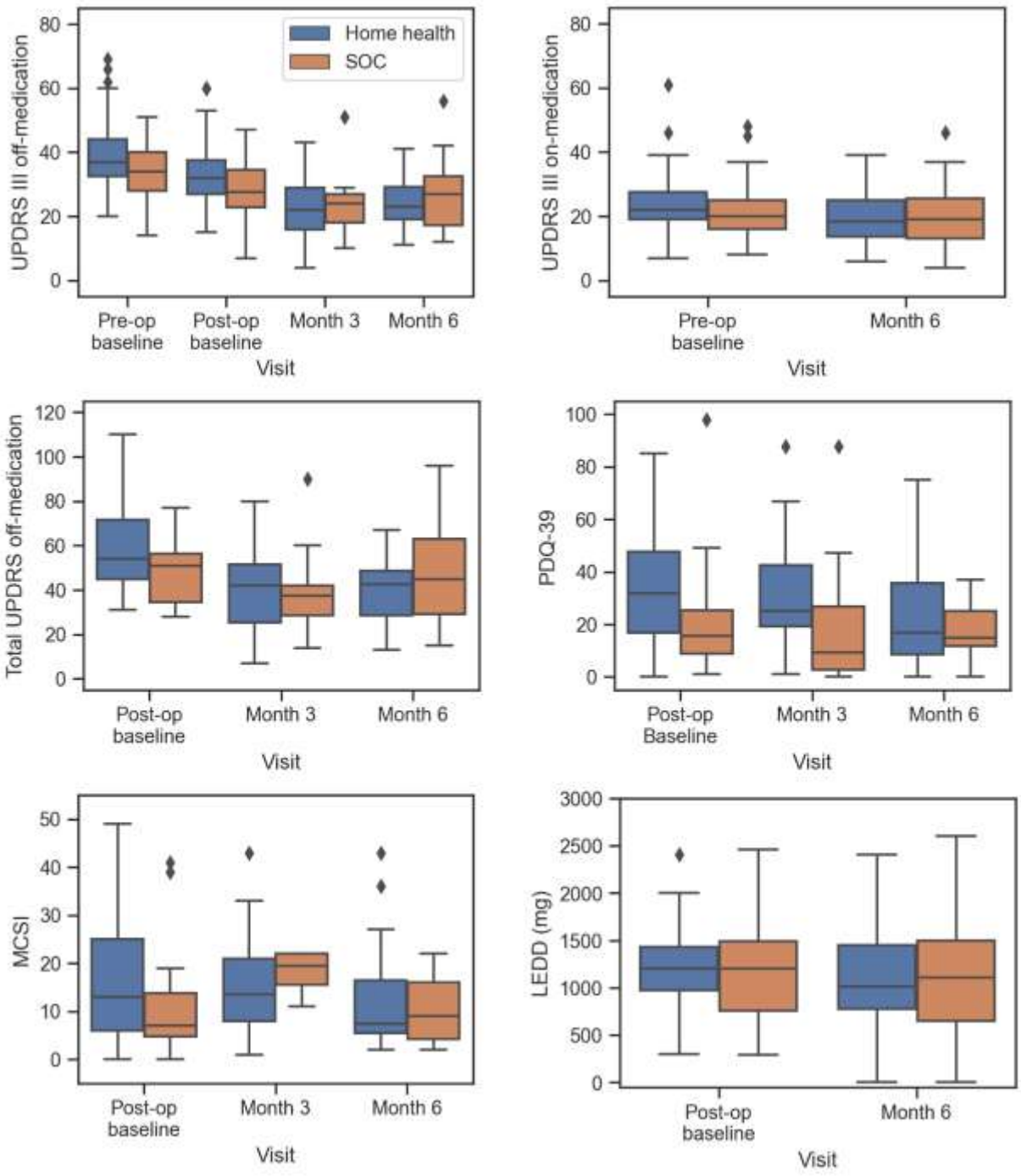
MAP DBS is a mobile decision support system that is scalable to the challenges presented by DBS programming. The only required equipment for an individual clinician is a device running Apple’s iOS operating system. This framework makes MAP DBS a highly distributable platform that can be deployed to a wide range of practitioners. Our first prospective MAP DBS study demonstrated the capability of the platform to be integrated into the workflows of several DBS centers in the United States. Generation of the patient-specific models currently requires approximately 30 minutes of supervised effort and approximately four hours of computation time utilizing a single multicore CPU. Our current infrastructure utilizes remote generation of models that is triggered by uploading patient imaging to a Health Insurance Portability and Accountability Act (HIPPA) compliant server. The computational models are then automatically pushed back to the client iOS device. We anticipate that with additional development it is feasible to convert MAP DBS model generation into a completely automated process.



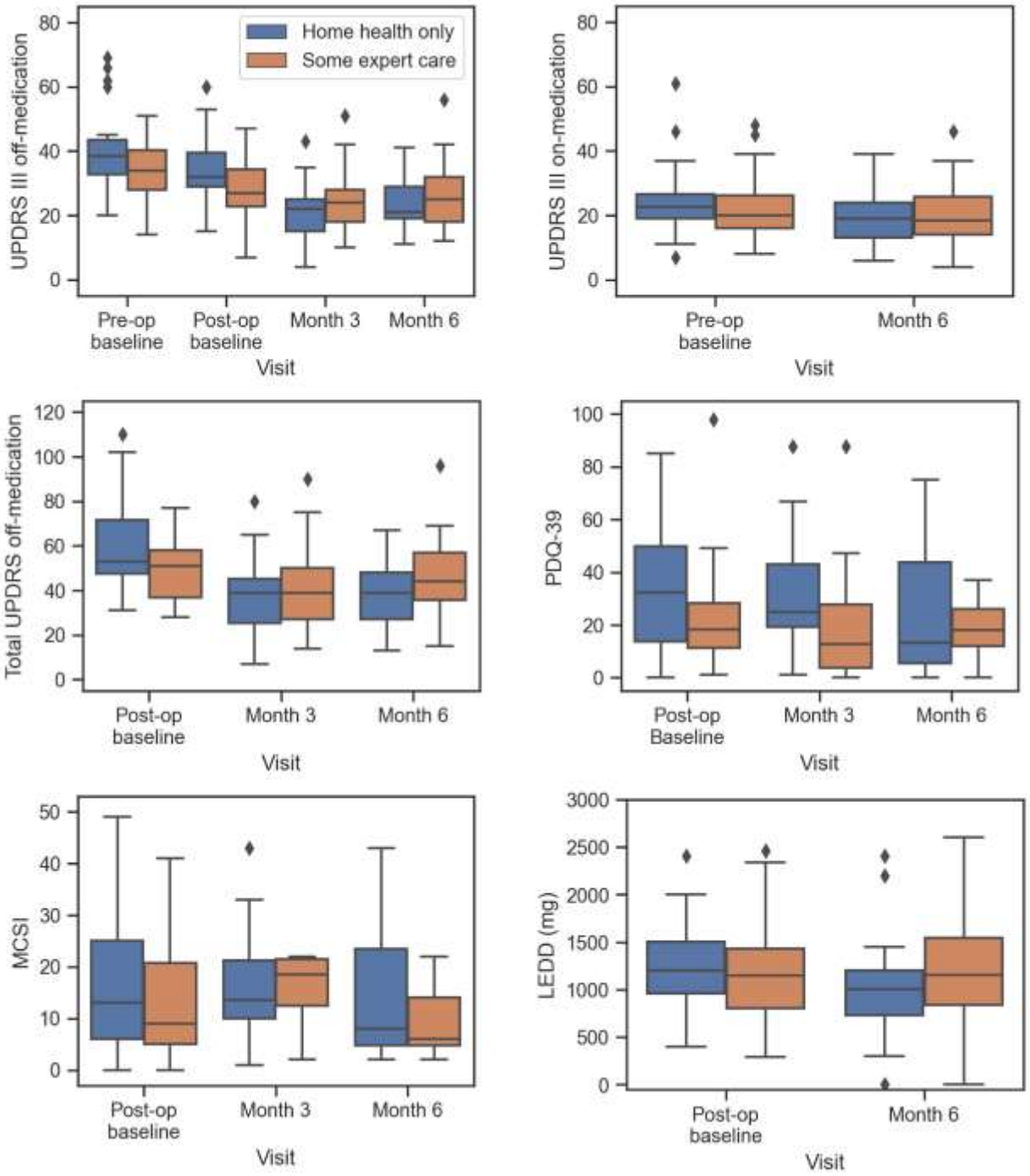
eFigure 1. iPad screenshots of the MAP DBS interface. MAP DBS supports both a 3D view of patient anatomy and stimulation (right), as well as a 2D view with multiple coregistered MRI and CT image volumes (left). These examples of the interface are from a patient with a Medtronic 3389 DBS lead implanted in the left globus pallidus internus (GPi). The globus pallidus externus (GPe) is shown for additional context. The top left portion of the screen in both the 3D and 2D views contain the stimulation parameters chosen by the user to generate the volume of tissue activated (VTA).

eTable 1. Comparison of mean number of DBS postoperative management visit types between arms. Patients randomized to home health underwent fewer clinic and in-person (in clinic or in home) visits. There was no statistically significant difference in total visits (defined as the sum of in-person and phone). Data are: mean ± standard deviation (n).

Visit type	SOC (n)	Home health (n)	p-value
Clinic	4.8 ± 0.4 (19)	0.4 ± 0.8 (23)	< 0.0001
In-person	4.8 ± 0.4 (19)	3.5 ± 1.0 (23)	< 0.0001
Total	4.8 ± 0.4 (19)	5.2 ± 0.7 (23)	0.06



eFigure 2. Clinical rating scales and LEDD values for patients over the study period grouped by study arm. There were no statistically significant differences between the groups in the change from baseline to six-month outcomes for any of the metrics.
UPDRS = Unified Parkinson's Disease Rating Scale, Total UPDRS = sum of parts I, II, III, and IV, PDQ-39 = 39-question Parkinson's disease rating scale, MCSI = Multidimensional Caregiver Strain Index, LEDD = levodopa equivalent daily dose.



eFigure 3. Subanalysis of clinical rating scales and LEDD values for patients over the study period grouped by patients who underwent at least one clinic DBS postoperative management session compared to those exclusively managed by home health. There were no statistically significant differences between the groups in the change from baseline to six-month outcomes for any of the metrics.
UPDRS = Unified Parkinson's Disease Rating Scale, Total UPDRS = sum of parts I, II, III, and IV, PDQ-39 = 39-question Parkinson's disease rating scale, MCSI = Multidimensional Caregiver Strain Index, LEDD = levodopa equivalent daily dose.

eTable 2. Correlation of change from baseline to six-month outcomes for rating scales with order of initial DBS postoperative management visits for patients randomized to home health. Order of postoperative management visits is used to represent the DBS programming experience level of the home health nurse. The positive Spearman's correlation coefficients (r) indicate an insignificant trend toward a decrease in patient benefit as the study progressed.

UPDRS = Unified Parkinson's Disease Rating Scale, Total UPDRS = sum of parts I, II, III, and IV, PDQ-39 = 39-question Parkinson's disease rating scale, MCSI = Multidimensional Caregiver Strain Index

Rating scale	n	r	r^2	p-value
UPDRS III off-medication	16	0.418	0.17	0.11
UPDRS III on-medication	16	0.250	0.06	0.35
Total UPDRS off-medication	16	0.129	0.02	0.63
PDQ-39	15	0.104	0.01	0.71
MCSI	12	0.175	0.03	0.59

eReferences

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