# DEEP BRAIN STIMULATION (DBS) EXPERIENCE IN A TERTIARY REFERRAL CENTER

**Joohi Jimenez-Shahed, M.D., Jake Keller, Christine Hunter, R.N., Joseph Jankovic, M.D.**
Parkinson's Disease Center and Movement Disorders Clinic, Department of Neurology, Baylor College of Medicine, Houston, Texas

## OBJECTIVES

1. Describe the characteristics of an active DBS cohort at an academic, tertiary care center.
2. Identify trends in DBS care for patients with Parkinson's disease (PD)

## BACKGROUND

The Parkinson's Disease Center and Movement Disorders Clinic (PDCMDC) has been involved in surgical treatment of PD and other movement disorders for several decades and the forefront of DBS research since 1998. Although the efficacy and safety of globus pallidus interna (GPi) and subthalamic nucleus (STN) DBS in advanced PD are established, there is growing interest in utilization of DBS earlier in the course of the disease. Novel imaging and neurophysiologic techniques are currently being assessed at the PDCMDC to better define the role of DBS not only in PD but also in other movement disorders.

## METHODS

A retrospective review was performed to characterize a cohort of DBS patients followed or implanted at the PDCMDC since 2010. In addition, neurophysiologic recordings obtained during DBS placement illustrate how this technology may lead to optimization of DBS patient outcomes.

Our DBS team consists of 4 movement disorders specialists, an adult and pediatric functional neurosurgeon, 2 neuropsychologists, 2 clinical post-doctoral fellows, a research coordinator, a research nurse, and administrative and support staff.

Monthly consensus meetings with journal reviews and an annual research symposium are held.

**DBS referral**
- Relevant motor examination
- Neuropsychological testing

**DBS Consensus Team Review**
- Candidate: Y/N?
- Target, laterality
- Research considerations

**Neurologist reviews outcome**
- Discuss expectations
- Discuss IPG type
- Review research options

**Neurosurgery referral**
- Surgery scheduled

### Available DBS Surgical Techniques

Frame-based, frameless, MRI-guided, and CT-guided placement

## RESULTS

### Characteristics of a 4-year cohort of patients with DBS for movement disorders

**All Implants by target and indication (N=271)**

| | Target Nucleus | | | | |
|---|---|---|---|---|---|
| Category | STN | GPi | ViM | Other | Total |
| Parkinson's Disease | 114 | 33 | 8 | 5 STN/ViM | 160 |
| Essential Tremor | 0 | 1 | 56 | 1 STN/ViM | 58 |
| Dystonic Tremor | 0 | 0 | 2 | 0 | 2 |
| Dystonia | 0 | 27 | 1 | 0 | 28 |
| Tourette Syndrome | 0 | 10 | 0 | 1 Cm-PF | 11 |
| Cerebellar Outflow Tremor | 0 | 0 | 7 | 0 | 7 |
| Other* Mvmnt Disorders | 0 | 4 | 1 | 0 | 5 |
| Total | 114 | 75 | 75 | 7 | 271 |

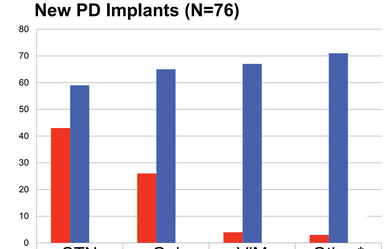
**New implants by year, target and indication (n=132)**

| | Year of Implantation | | | | | | |
|---|---|---|---|---|---|---|---|
| Category | 2010 | 2011 | 2012 | 2013 | 2014 | Total (%) | Mean age (SD) |
| Parkinson's Disease | 12 | 13 | 22 | 10 | 19 | 76 (58) | 62yrs (8.9) |
| Essential Tremor | 6 | 7 | 4 | 5 | 4 | 26 (20) | 64yrs (10.1) |
| Dystonia | 3 | 5 | 2 | 5 | 3 | 18 (14) | 52yrs (14.8) |
| Tourette Syndrome | 1 | 3 | 1 | 0 | 1 | 6 (5) | 20yrs (4.9) |
| Cerebellar Outflow Tremor | 0 | 0 | 0 | 1 | 0 | 1 (1) | -- |
| Other* Mvmnt Disorders | 2 | 0 | 0 | 0 | 3 | 5 (4) | -- |
| Total | 24 | 28 | 29 | 21 | 30 | 132 | |

*Other = SPG11, myoclonus, chorea with FOXG1 mutation, RLS
Mean age reflects age at implantation

### PD and ET Cohorts

**New PD Implants (N=76)**




*Other = dual targets

| | STN | Gpi | ViM | Other* |
|---|---|---|---|---|
| N | 43 | 26 | 4 | 3 |
| mean age (yrs) | 59 | 65 | 67 | 71 |
| SD | 8.6 | 8.7 | 2.9 | 10.1 |

**Rationale for target selection (PD cases)**

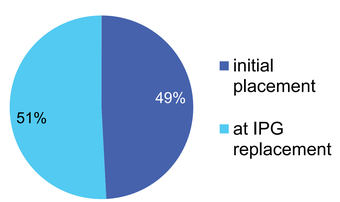
| STN | GPi |
|---|---|
| Refractory tremor | Presence of dystonia |
| Need for med reduction | + Cognitive impairment |
| Typical motor complications | + Mood disorder |
| | Significant gait disorder |
| | Impulse control disorder |

- Mean MDS-UPDRS ON – 22.8 (SD=14.1)
- Mean MDS-UPDRS OFF – 47.9 (SD=16.6)

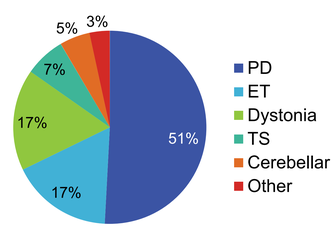
- Mean TETRAS (n=10)
  - ADL – 34.7 (SD=8.9)
  - Perf. – 31.8 (SD=9.6)
- Mean TRG (n=9) – 24.3 (SD=10.5)

### Implantable pulse generators – placement and replacement

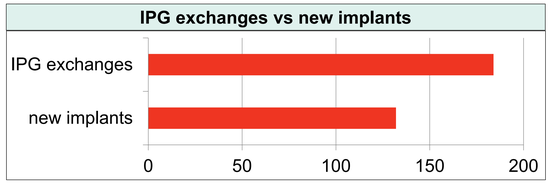
**Proportion of Rechargeable IPGs**



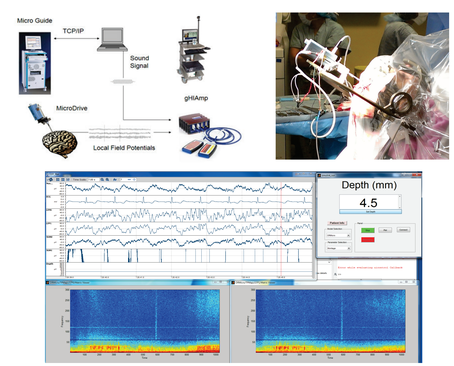

**Rechargeable IPGs by diagnosis**




**IPG exchanges vs new implants**




### Intraoperative Neurophysiology




Real-time intra-operative LFP analysis during DBS electrode placement (courtesy of Dr. Nuri Ince, PhD, Biomedical Engineering, Univ of Houston) obtained concurrently with microelectrode recording. LFPs are also evaluated at IPG replacement (not shown).

## CONCLUSIONS

- A comprehensive database with a well-characterized cohort is critical for ongoing monitoring of DBS patients and to facilitate DBS-related research.
  - Targeting strategies, programming techniques, indications, implantation techniques and the utility of neurophysiologic techniques are currently being explored and investigated
- DBS for PD continues to represent the largest group (58%) of implanted patients in our cohort.
  - The target for stimulation is recommended pre-operatively by consensus review but evidence-based guidelines are lacking
  - Neurophysiologic patterns (e.g., LFPs) may provide further insight intra-operatively
- There is a high acceptance rate of rechargeable batteries at initial implantation despite greater maintenance requirements.
- Image-guided DBS placement is a safe and effective approach.
- Investigation of local field potentials will help understand the neurophysiologic basis of movement disorders and may yield data important to decisions such as target selection or stimulation parameters that will eventually lead to "closed loop" DBS therapy.

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