ABCs of DBS

Where we were
and where we are going.

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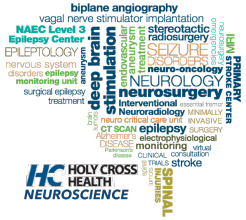
Disclosures



- Zachary T. Levine MD FAANS
- Clinical Professor of Neurological Surgery, GWU
- Director of Neurosurgery and Neuroscience, Holy Cross Health
- Partner and President of National Capital Neurosurgery
- Speakers Bureau
  - Abbott Labs
  - Medtronic Inc.

NATIONAL CAPITAL
NEUROSURGERY

History of Movement Disorder Surgery

- 1930-1940 “Tractotomy”
  - Severing connections in the brain
- 1940’s Stereotactic Pallidotomy and Thalamotomy: Spiegel and Wicis
  - Burning holes in the brain
- 1950’s Choroidal Artery Ligation: Cooper
  - Surgical strokes: 10-15% complication rate
- 1970’s - 90’s Resurgence of Pallidotomy: Laitenen
- 1980’s to present Neural Transplantation: Madrazo
- 1975- treatment for chronic pain
- 1987’s to present for Movement Disorders Benibid
- 1990’s Chronic Stimulation
- Current
  - lesioning of the brain using U/S
  - Alternative method of L-Dopa Administration
  - Directional leads to minimize side effect

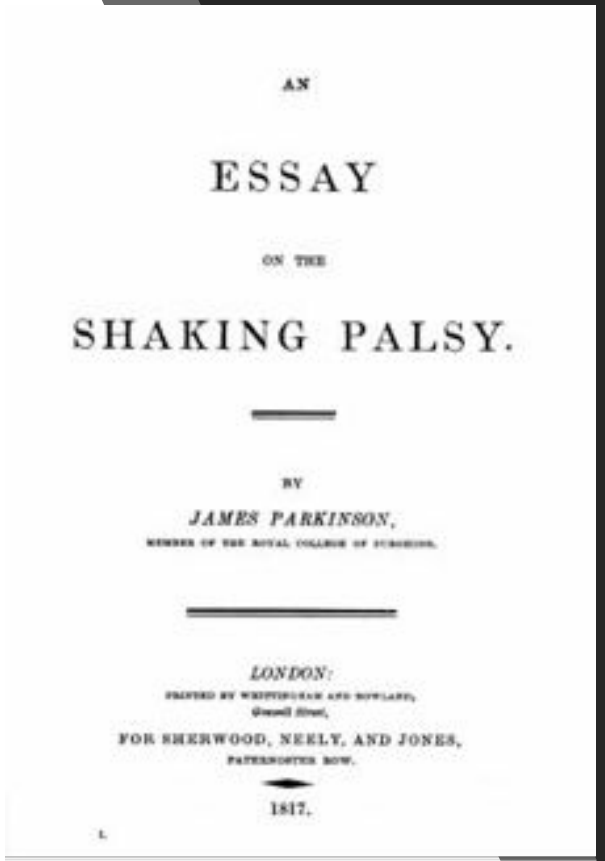
"That's amazing—I was just thinking the same thing."

Neural Prosthetic

- Electrical stimulation to modulate output from target
- Based on "lesioning" studies
- Mimic lesioning with fewer adverse events
- Symptomatic treatment
  - Tremor
  - Bradykinesia
  - Rigidity
  - Freezing
  - Dystonia
  - Dyskinesia

Neural Prosthetic

- DBS limitations - Cannot treat -
  - Cognitive symptoms - memory, thinking
  - Gait and balance issues
  - Autonomic symptoms
  - urinary issues
  - blood pressure



AN

ESSAY

ON THE

SHAKING PALSY.

BY

JAMES PARKINSON,

LONDON:

FOR SHERWOOD, NEELY, AND JONES,

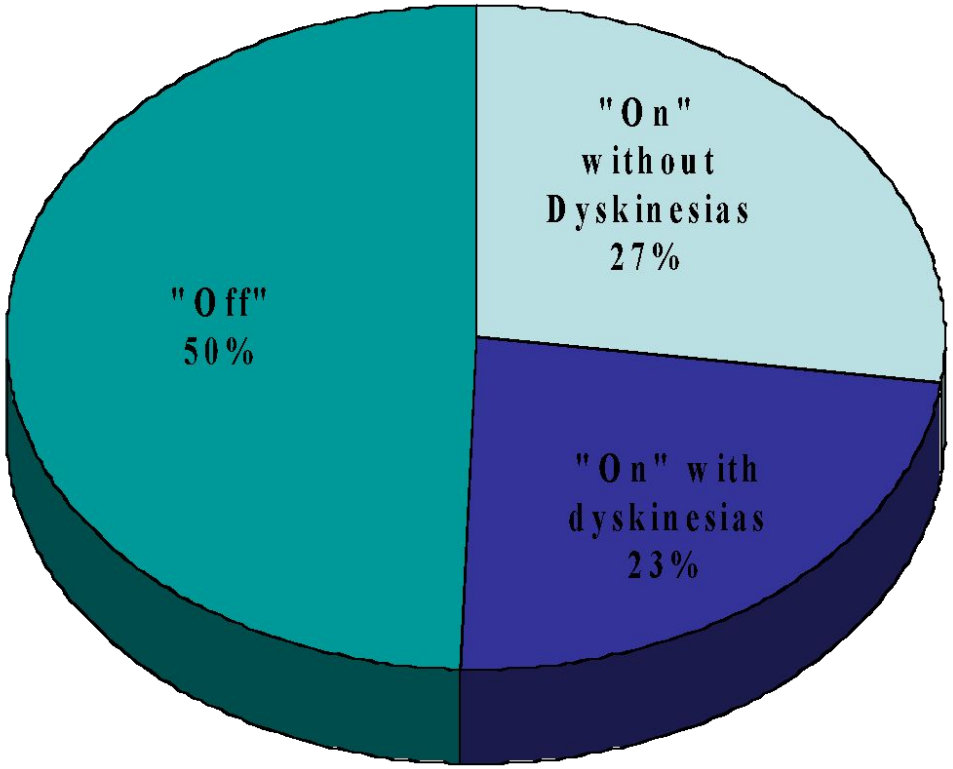
1817.

Parkinson's Disease

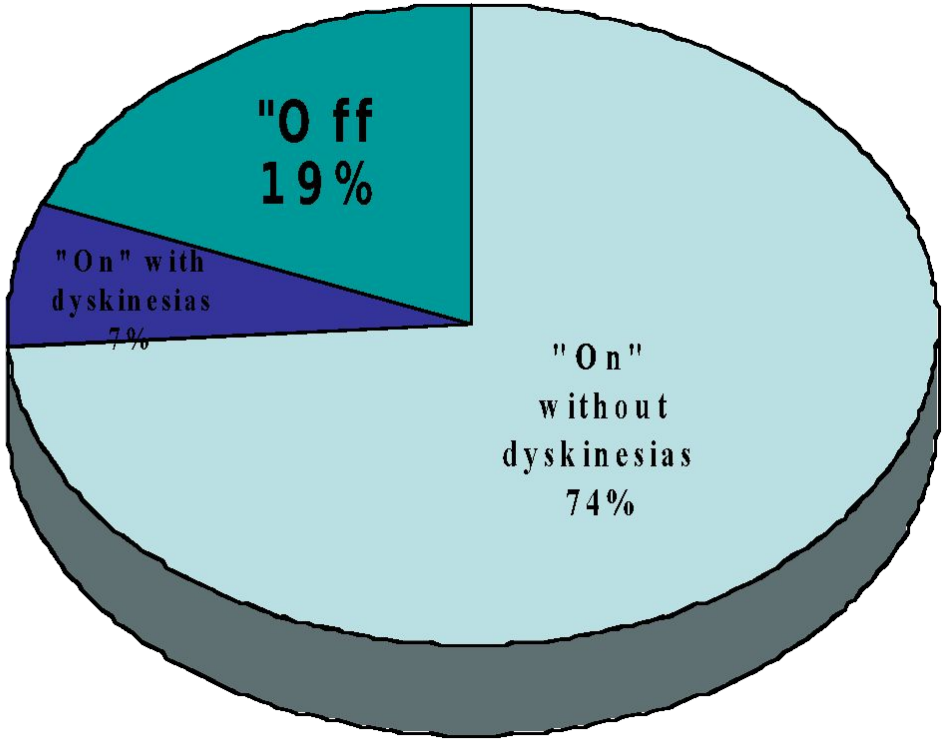
- Death of Dopaminergic Cells in the brain - not just the *SN*
  - Suicide? - apoptosis
  - Murder? - toxic exposure
  - Both
  - genetic predisposition
  - toxin exposure

Deep Brain Stimulation for PD

Baseline Assessment



6 Months after DBS



NEJM Vol 345 No 13 9/27/2001

DBS v. Best Medical Therapy for PD

- Bilateral Deep Brain Stimulation vs Best Medical Therapy for People with Advanced Parkinson's Disease - JAMA 2009; 301(1) 63-73
- 255 Randomized Patients 121 - DBS, 134 - Best Medical Therapy - compared "on time." motor function, QOL, Cognitive function and adverse events
- DBS patients gained an average of 4.6h/d of "on time" vs. 0h/d $p<0.001$
- 71% improvement of motor function for DBS vs. 32% medical group $p<0.001$
- 7/8 QOL scores significantly improved with DBS as did the summary of QOL vs. No significant improvement $p<0.001$
- Cognitive function slightly decreased at the 6month mark with DBS
- More adverse events with DBS $p<0.001$ (49 adverse events with DBS vs 15)

- Conclusion: Deep Brain stimulation is superior to best medical therapy for people with Parkinson's Disease, in regard to increased "on time", UPDRS scores and Quality of Life self assessment.

DBS Techniques

- Awake v Asleep
- Microelectrode recording
- Test Stimulation
- Image guided placement
- Frame based
- Frameless
- Robotic

Awake vs. Asleep

Asleep Implantation

- Image guidance only – MRI placement
- Electrophysiologic guidance
- No testing for benefit/side effect

Awake Implantation

- Image guidance - Not for MRI placement
- Electrophysiologic guidance
- Testing for benefit/side effect

DBS - Stereotactic Frames

- Frame based surgery –
  - Offers submillimeter accuracy
  - Older technique – more cases have been done with the frame
  - Requires imaging the day of surgery – lengthens the surgery
  - Rigidly affixes the patient to the bed – has led to discomfort
  - One frame for all patients – some patients are not suitable
  - Frame placement may effect accuracy

DBS - Frameless

- Frameless Surgery
  - Offers submillimeter accuracy (no different than frame based)
  - Limited number of cases (<50% of current cases)
  - Imaging is all done before the surgery – shorter operative time
  - Patient may move on operating table with out sacrificing accuracy
  - No limitations based on patient anatomy or size

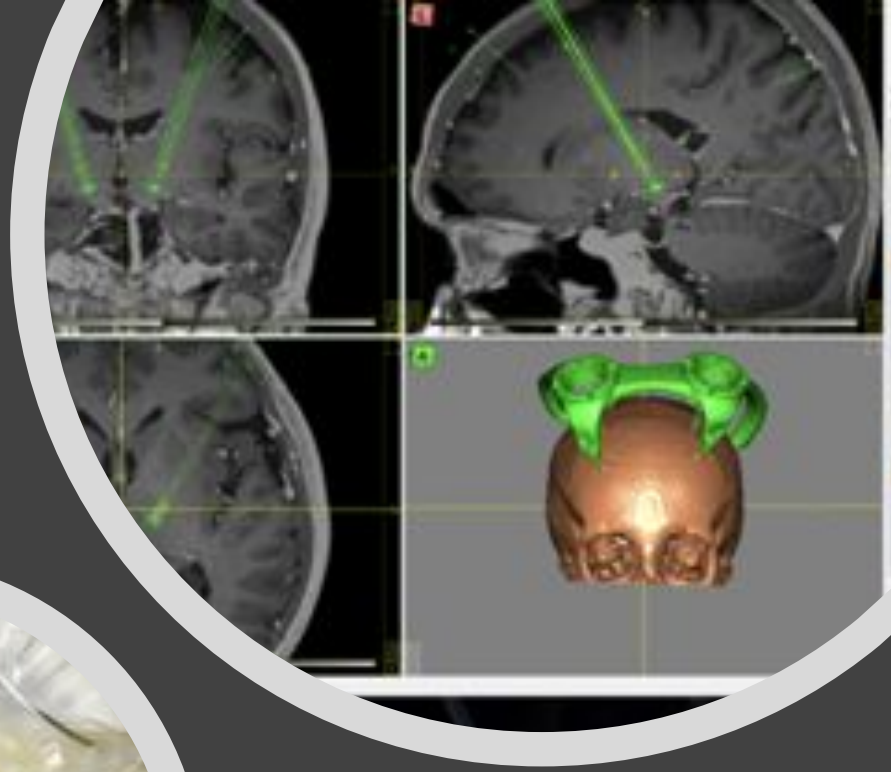
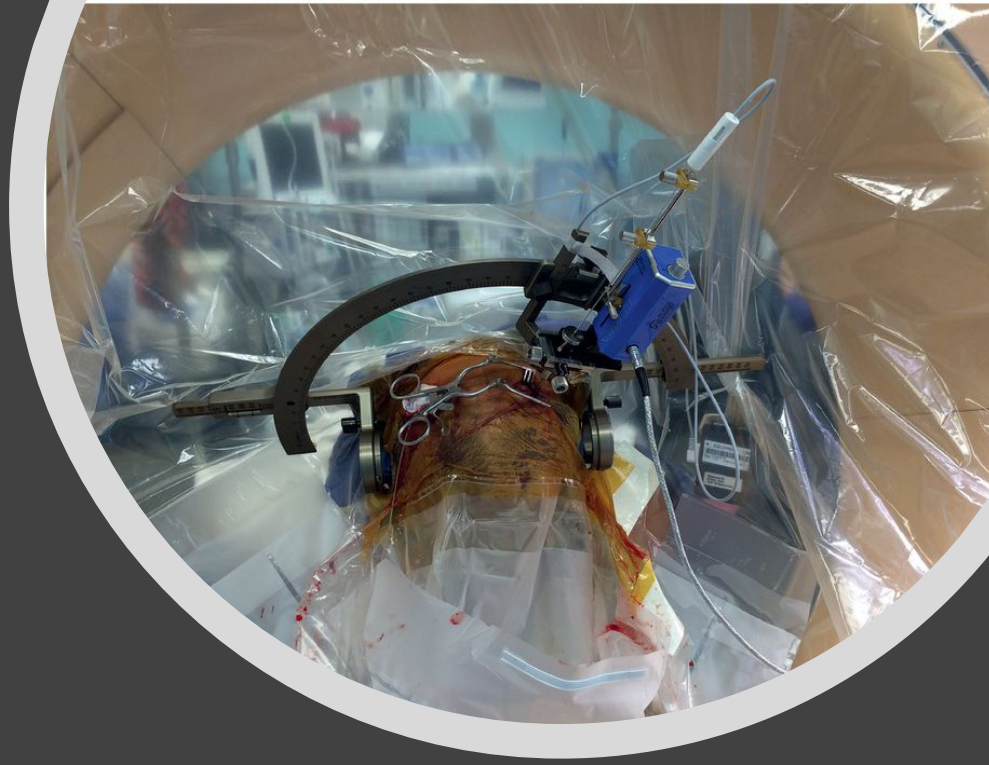
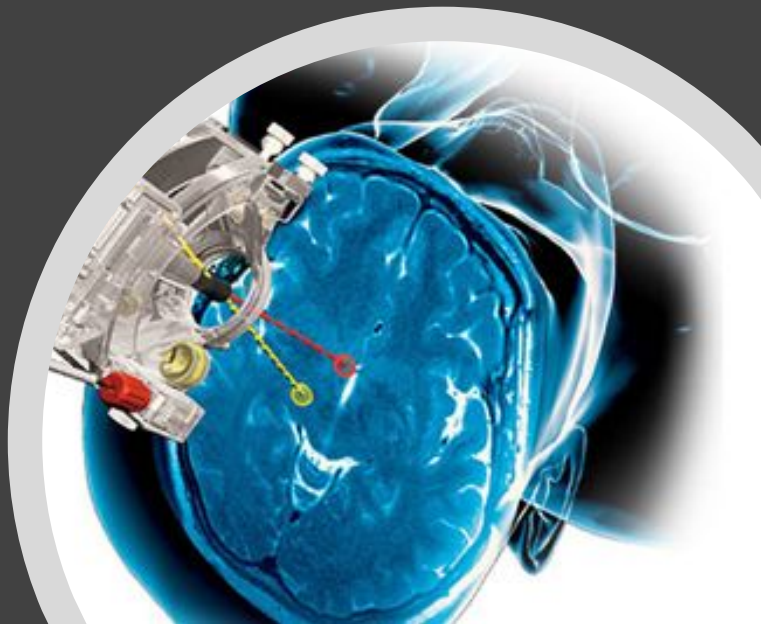


Image Guided Surgery

- DBS done in the MRI scanner
  - Cannot do microelectrode recording (MER)
  - Cannot do test stimulation
  - Patient is asleep
- DBS done with CT
  - Fused with MRI for detail and anatomic delineation
  - MER can be done
  - Test stimulation is difficult when patient is asleep





Robots and DBS

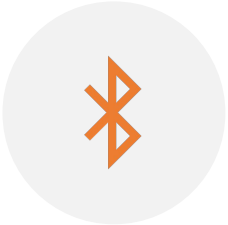
- Pointers
  - Surgeon uses Robot to point
  - Planning is done the same
  - MER possible
  - Test stimulation possible

DBS Technology

DIRECTIONAL LEADS

RECHARGEABLE BATTERIES

PRIMARY BATTERIES

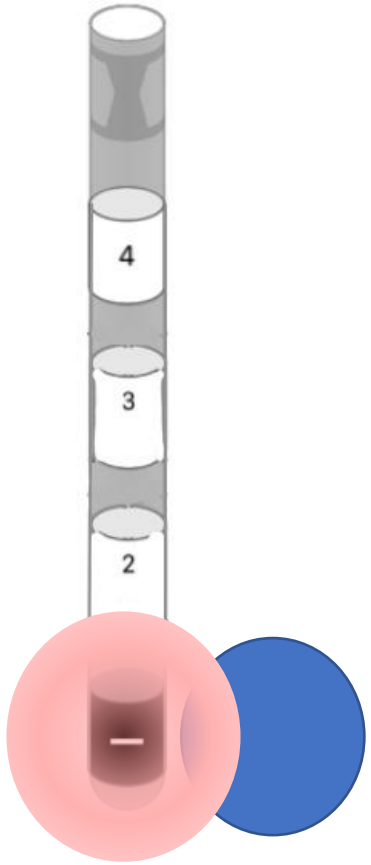


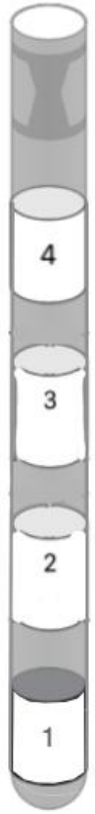
BLUETOOTH COMMUNICATION

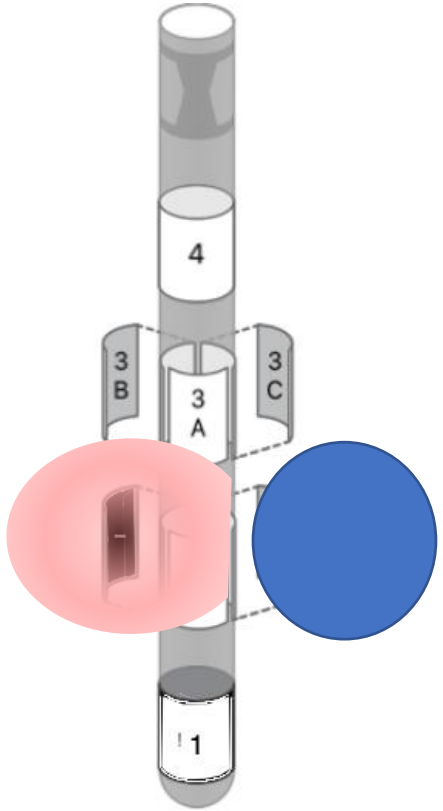
RF COMMUNICATION

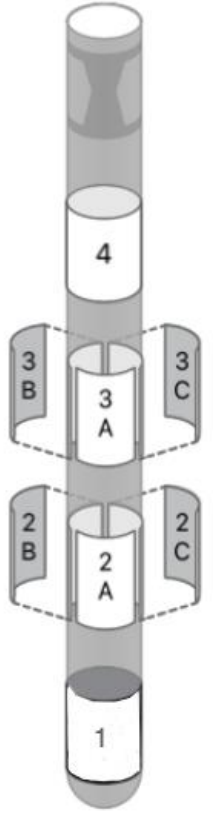
MRI CONDITIONAL

Directional Leads









Batteries – Pulse generators

Rechargeable batteries

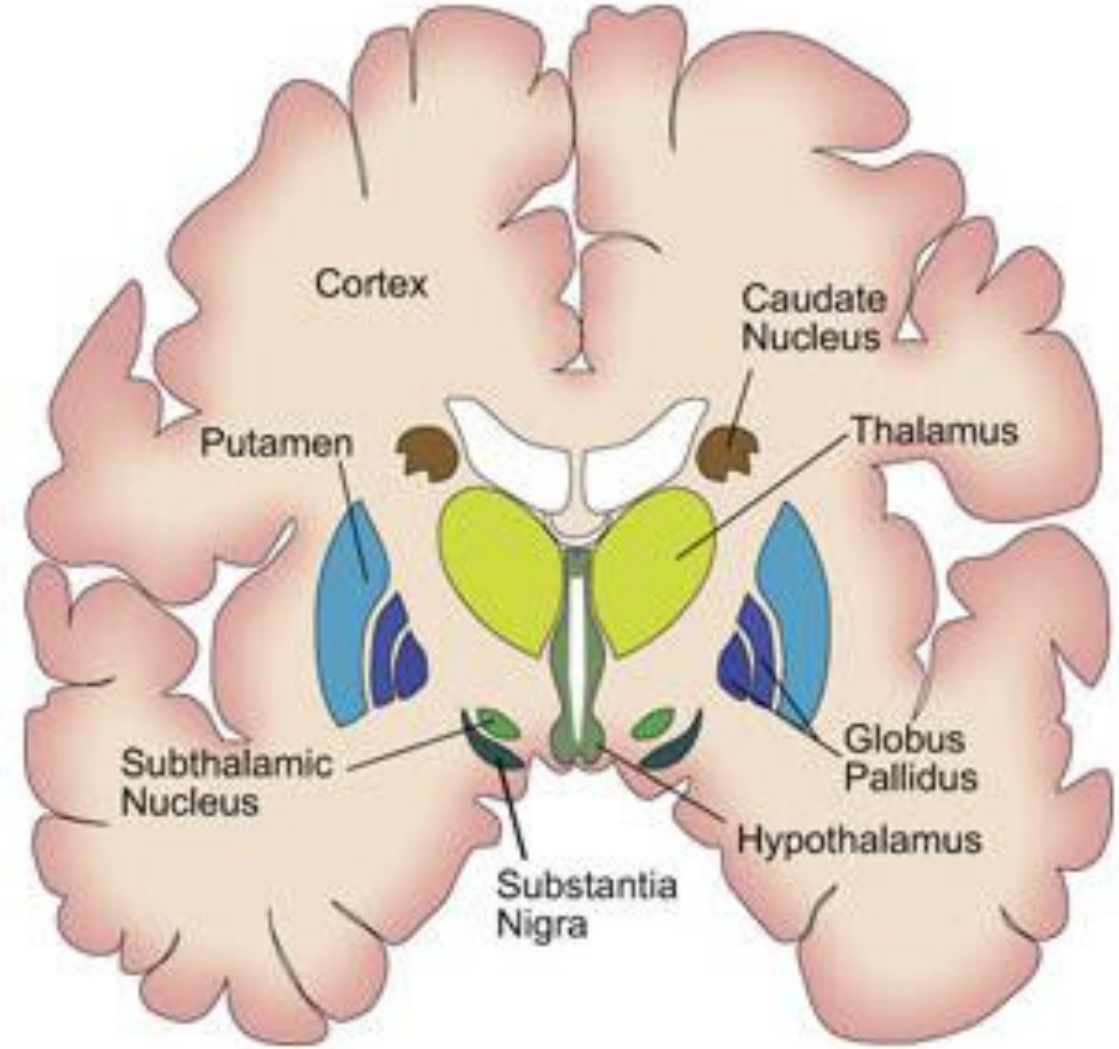
- Last longer
- Requires daily recharge
- Recommend if battery drain <2 years
- Will need eventual replacement
  - (15 years)
- No upgrade

Primary Cell

- Last no more than 5-6 years
- Very little to no daily maintenance
- Can abruptly loose charge
  - Emergency replacement
- Upgrade with battery changes

DBS Targets

- Subthalamic Nucleus (STN)
- Globus Pallidus, internal segment (GPi)
- Ventral Intermediate nucleus (Vim)



GPi Reasoning

- Significant Dyskinesia with lower doses of L-Dopa (low LED*)
- More gait and postural issues
- Speech preservation important
- Behavioral concerns
  - Depression
  - Aggression
- Maintenance L-dopa dosing

- *Levodopa Equivalent Dosing

STN reasoning

- Reduction of LED
  - Side effect issues
- Advanced PD
- Tremor predominance
- General considered better target
- Dyskinesia not a predominant problem
- Ease of programming
  - Immediate feedback on lead efficacy

Vim Reasoning

- Medication well tolerated
  - Treating most symptoms
- Tremor Predominant
- Advanced age with disabling tremor
- Less likely to lower LED
- Does not treat bradykinesia or rigidity as well

Surgical Goals in DBS

SAFELY place the DBS lead in a location that mitigates symptoms with minimal or no side effects. Keeping the patient comfortable.

1. Safety

2. Accuracy

3. Benefit

DBS Principles

A well placed lead will improve symptoms in someone with idiopathic Parkinson's Disease

Symptom improvement does no mean symptom arrest in all patients

Medication reduction is NOT a primary goal for DBS

Improved quality of life IS a primary goal for DBS