Deep Brain Stimulation Surgery:

What to Expect

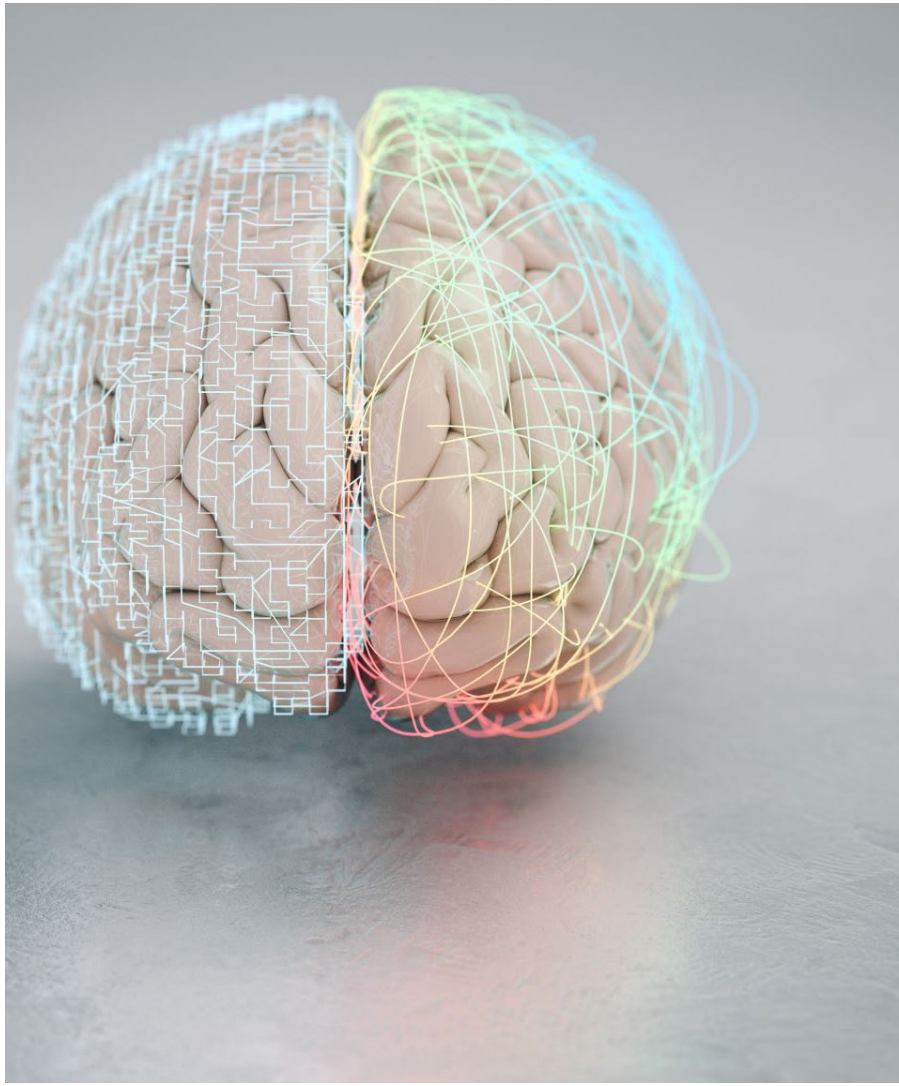
LAURA SPERRY, ANP-C

CLINICAL DIRECTOR, DEEP BRAIN STIMULATION PROGRAM

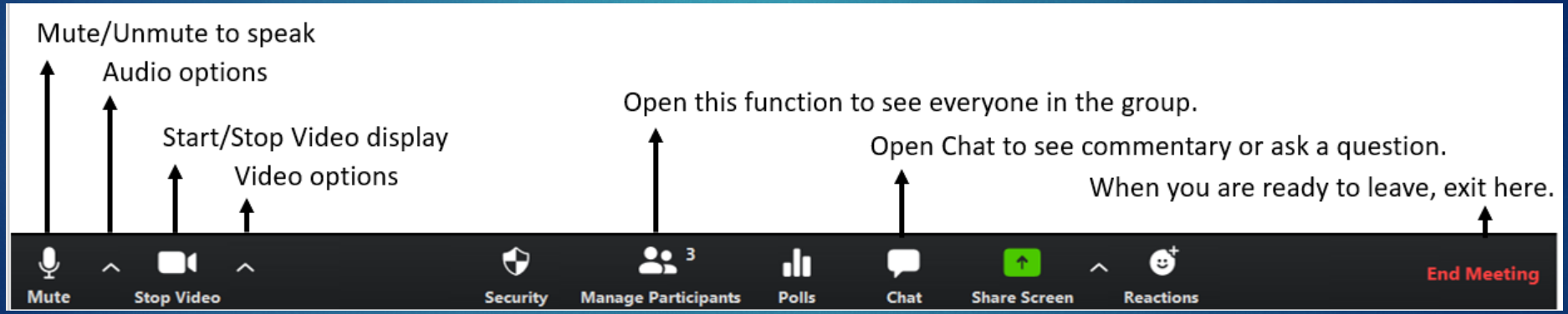
COORDINATOR, PARKINSON'S FOUNDATION CENTER FOR EXCELLENCE

Parkinson's Foundation
CENTER OF EXCELLENCE

UCDAVIS HEALTH
Departments of Neurology and Neurological Surgery
Center for Movement Disorders and Neurorestoration



Zoom Overview



U.C. Davis
Deep Brain Stimulation Team

Neurosurgery:

- David Brandman, MD, PhD
- Kia Shahlaie, MD, PhD
- Stephano Chang, MD, PhD
- Claire Basco, MSN, FNP-BC, CNRN
- Peggy Jung, MSN, ACNP-BC
- Daniel Ayana, DNP, AGNP-BC
- Surgical Coordinator: Robert Dillman

- Movement Disorder Neurologists
- Epileptologists
- Neuropsychologists

Neurophysiology:

- Dr. Jie Zheng, PhD

Program Director:

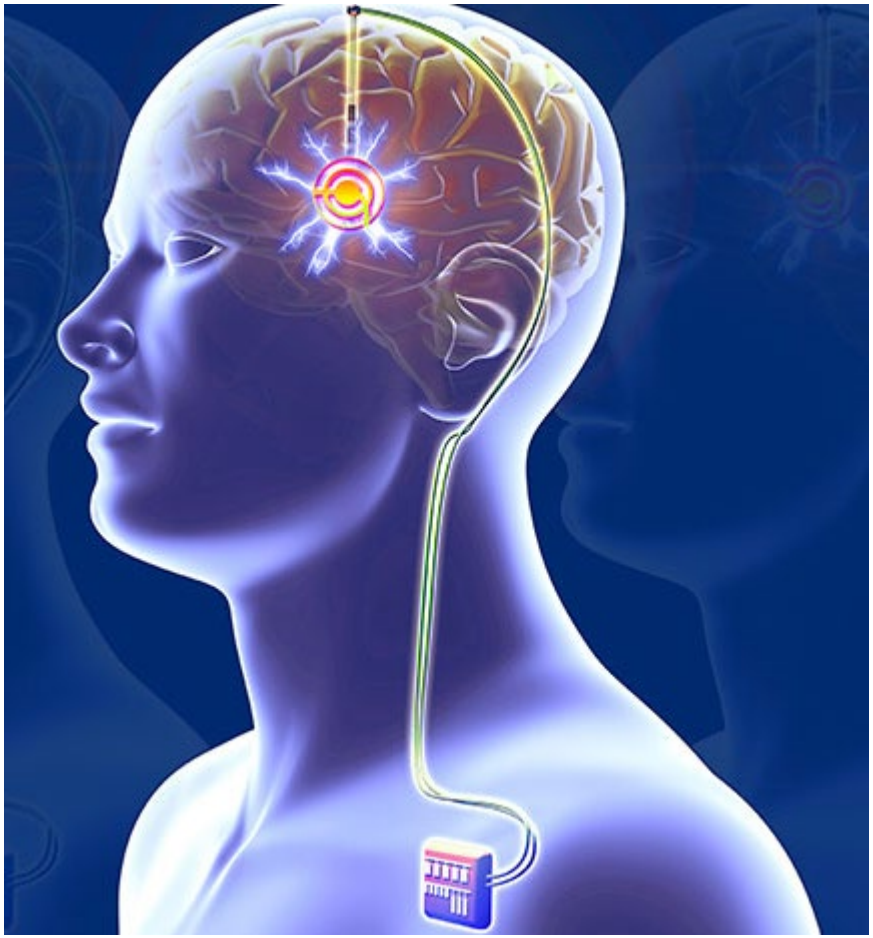
- Laura Sperry, MSN, ANP-BC

Clinic Coordinator:

- Kandis Kaltenbach MA II, Movement Disorders

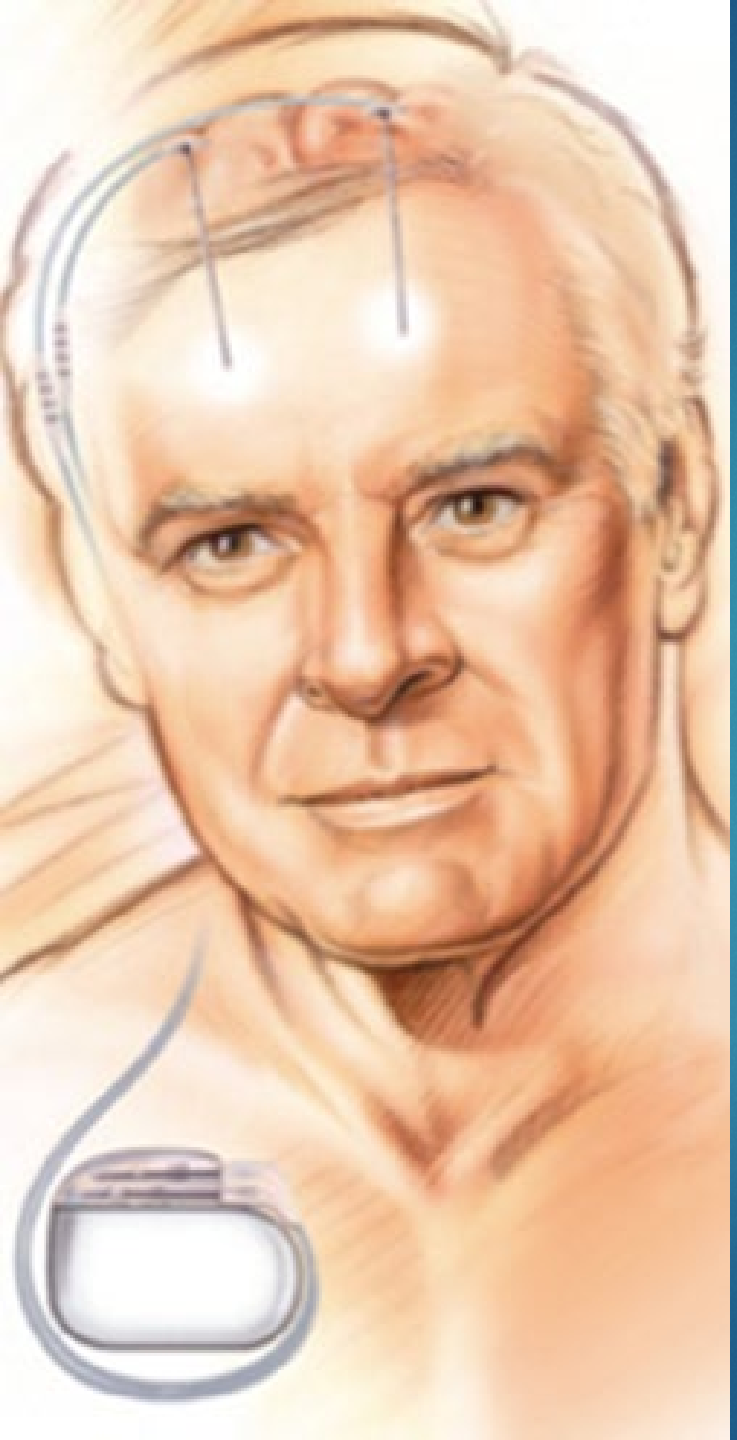
What is Deep Brain Stimulation (DBS)?

- DBS is a neurosurgical procedure that involves implanting brain electrodes and a neurostimulator ("brain pacemaker"; battery)
- The neurostimulator sends signals to specific targets in the brain
- Directly modifies brain activity in a controlled manner.
- Reversible
- DBS has been around since 1987
- Globally more than >208,000 people have been implanted with DBS (as of 2020)[1]



Strickland, 2017.

[1]Vedam-Mai V, 2021



Approved Indications

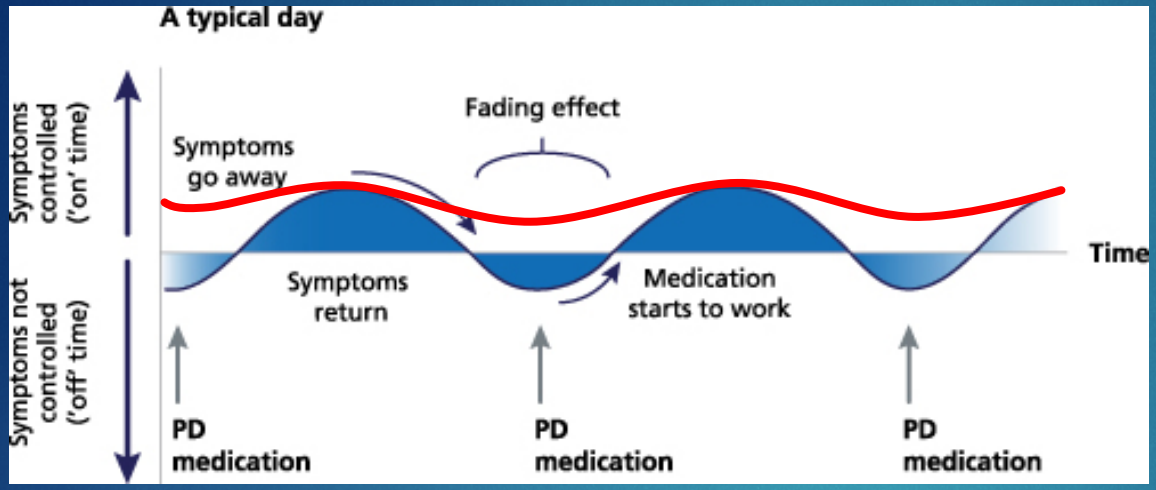
- Essential Tremor:
  - FDA approved in 1997
- Parkinson's disease:
  - FDA approved in 2002
  - FDA expanded approval in 2/2016 to include recent onset of motor complications after >4 years of PD
- Dystonia:
  - FDA approved in 2003
- Obsessive Compulsive Disorder:
  - FDA approved in 2009
- Epilepsy
  - FDA approved in 2018

Benefits of DBS for Essential Tremor

- Improved ability to do everyday activities
- Less tremor
- Less disability (as reported by the patients)

Benefits of DBS for PD

DBS is typically *as effective* as "best" dopamine response…



~ 30% improvement in motor scores

~ 40% improvement in ADL scores

~ 50% reduction in PD medication needs (STN)

Likely to improve:

- ✓ Tremor
- ✓ Rigidity (tightness)
- ✓ Bradykinesia (slowness)
- ✓ Dystonia
- ✓ Dyskinesia*

Unlikely to improve:

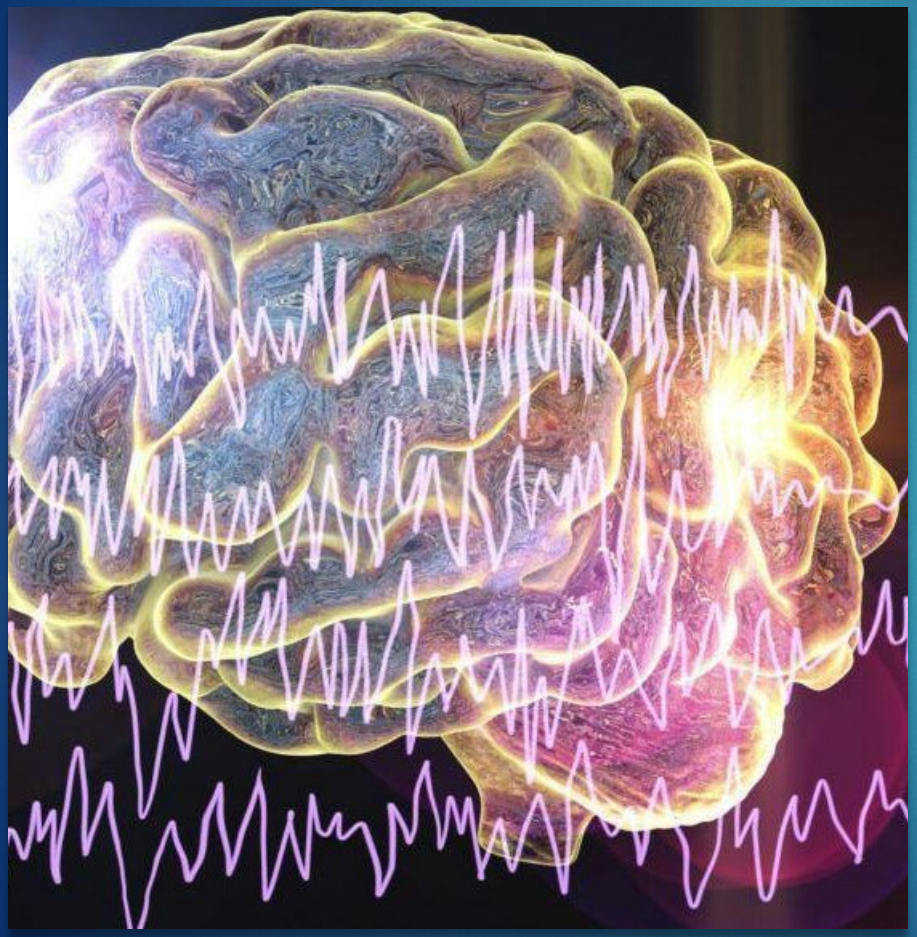
- ✓ Gait instability / falls
- ✓ Freezing of gait
- ✓ Speech
- ✓ Swallow
- ✓ Cognitive deficits

Benefits of DBS for Dystonia

- DBS can decrease the abnormal movements and postures of dystonia by 30-50%, depending upon the type of dystonia
- If you are being treated with Botox® before DBS surgery, you will likely resume treatment after surgery

Rupam, Rukmini, & Swetha, 2017.

Benefits of DBS for Epilepsy[1]



- Goal is to lessen the frequency and intensity of seizures
- DBS can be used for patients with epilepsy who have partial-onset seizures (+/- generalization), who have failed 3 or more antiepileptic medications
- Benefits sustained over time
  - Median 75% reduction in seizures at 7 years

[1] https://www.medtronic.com/us-en/healthcare-professionals/therapies-procedures/neurological/deep-brain-stimulation/indications/epilepsy/about.html#

What are the *risks* of DBS surgery?

- Stroke: bleeding or loss of blood flow to the brain (<2%)
- Medical problems: heart attack, blood clot to lungs or legs, breathing problems (<2%)
- Seizure (<5%)
- Infection: immediate or delayed (5%)
- Post-op confusion or hallucinations
- Men: difficulty urinating
- Mood changes
  - Mania: abnormally elevated mood
  - Depression, anxiety
  - Apathy
- Cognitive decline: word finding
- Falling

DBS Candidate Evaluation

Neurology consult with movement disorder specialist	Neurosurgery consult Neuropsychology consult Movement Disorders: On/ Off Testing (PD) or Off Testing (ET, Dystonia) Epilepsy: Diagnostic studies to evaluate source/ type of seizures Screening MRI
DBS CASE CONFERENCE:	Review results of evaluation with multidisciplinary team to develop recommendations for or against DBS surgery

DBS Hardware

Medtronic Activa/Percept DBS System

FDA Approved for:

PD (2002)

Essential Tremor (1997)

Dystonia (2003, HDE)

OCD (2009, HDE)

Epilepsy (2018)

Abbott/ St Jude Infinity DBS System

FDA approved for:

PD (2016)

ET (2016)

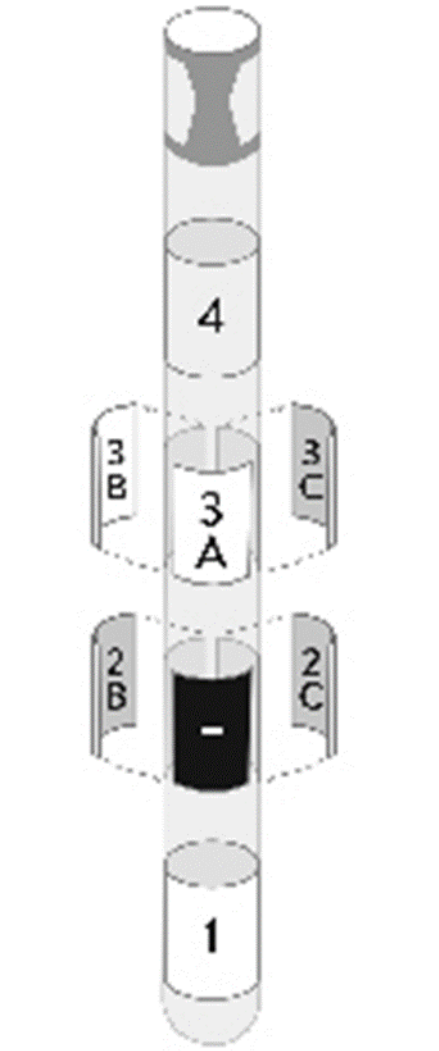
Boston Scientific Vercise/Genus DBS System

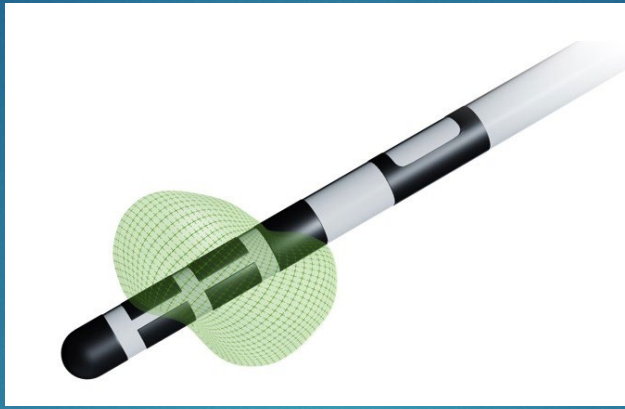
FDA approved for:

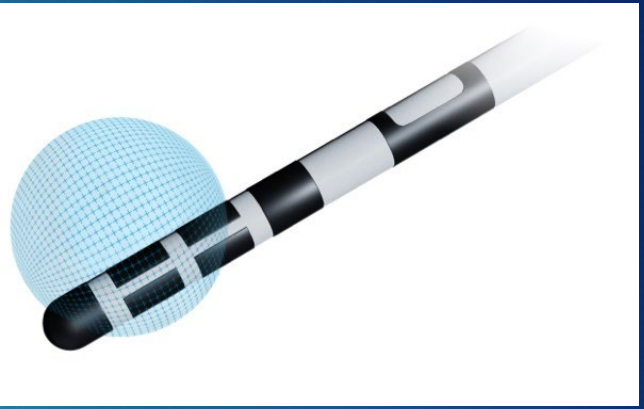
PD (2017)

ET (2021)

Directional Electrodes







- Complex anatomy makes precise targeting/ stimulation necessary to avoid side effects
- Side effects often limit therapeutic benefit
- Progression of disease often requires increased therapy settings
- Directional leads allow programmers to "steer" current to different parts of the brain, tailoring treatment to reduce side effects

https://www.bostonscientific.com/en-US/products/deep-brain-stimulation-systems/vercise-genus-dbs-system/leads.html

Internal Pulse Generators (IPGs)

Non-rechargeable "Battery" (SC, PC)

- **Benefits**:
  - "Set it and forget it"
- **Downsides**:
  - Replacement every 3-5 years
  - Larger size > RC IPG

- **Abbott:**
  - Infinity 5 & 7
- **Boston Scientific:**
  - Vercise Genus P16 or P32
- **Medtronic:**
  - Activa SC, PC
  - Percept PC

Rechargeable "Battery" (RC)

- **Benefits**:
  - Smaller than non-rechargeable IPGs
  - Approved for 15-year duration
- **Downsides**:
  - Must charge device 1-2 hours/week on average

- **Abbott:**
  - Liberta RC
- **Boston Scientific:**
  - Vercise Genus R16 or R32
- **Medtronic:**
  - Activa RC or Percept RC

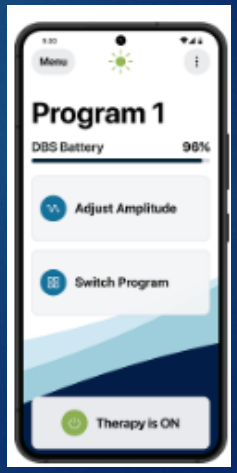
Patient Controller

- Monitor battery status
- Make minor adjustments to settings
- Turn device on/off for procedures
- MRI mode
- Unique features:
  - Medtronic: Track "Events" (medications, side effects etc.)
  - Abbott: Virtual Programming; Download to personal iPhone; Surgery mode

Medtronic

Abbott

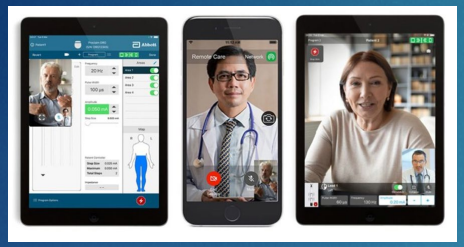
Boston Scientific



Unique Programming Features

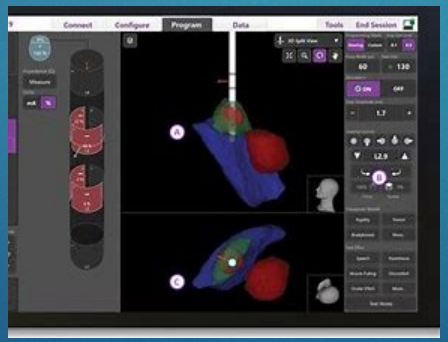
Abbott:

- **Neurosphere™ virtual clinic**: remote neuromodulation patient-care



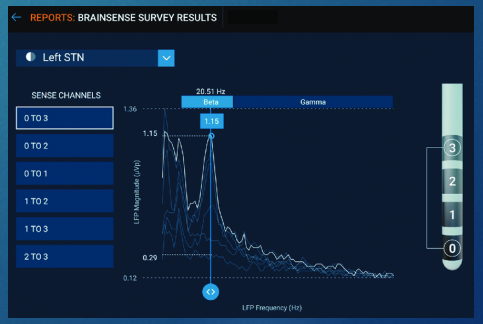
Boston Scientific:

- **Image Guided Programming**
  - **NEW: ILLUMINA 3D PROGRAMMING ALGORITHM**: creates customized stimulation field
- **Multiple Independent Current Control**: Increased control over the stimulation field - accurate and precise targeting



Medtronic:

- **Brainsense™ technology:** Captures brain signals during therapy which can be associated with patient-recorded events like symptoms, side-effects or medication intake.
  - **NEW: ADAPTIVE DBS (aDBS):** automatically adjusts to changing beta signals
  - **NEW: ELECTRODE IDENTIFER**: Identifiers which electrode(s) have the strongest signal
- **Optistim™ control:** Assign unique amplitude values to each electrode.



Surgery Preparation

Medical clearance by PCP, mental health providers and/or specialists

Stop use of tobacco and/or marijuana/ CBD products 1-3 months prior to surgery

Within 30 days: Preoperative evaluation with neurosurgery or PCP: labs, EKG, targeting brain MRi

Hold medications:

Estrogen: 4 weeks
Blood-thinning agents (aspirin, Plavix , NSAIDS etc.): 7-14 days

1-3 days prior: The Admissions Office will contact you with arrival time and instructions

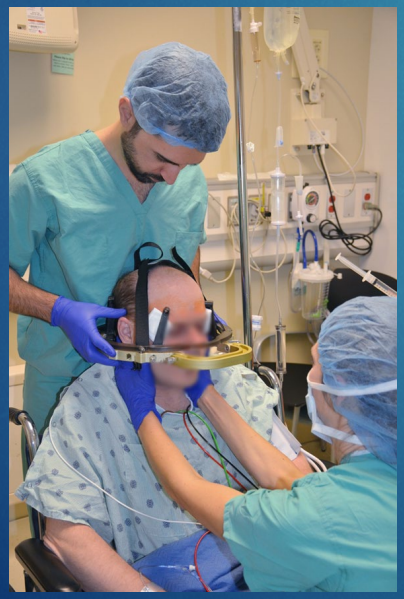
Movement Disorders: Hold movement disorder medications at midnight

*EPILEPSY: TAKE YOUR AED MEDICATIONS AS USUAL TO PREVENT AN INTRAOP SEIZURE!

What to Expect Day of Surgery: Stage 1 (lead implantation)

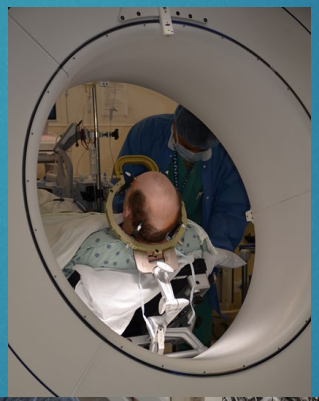
Frame Placement:

Pending surgeon, this may be done in preop with patient awake or in the OR after anesthesia induction



Head CT:

Merged with the pre-op MRI to ensure accurate targeting



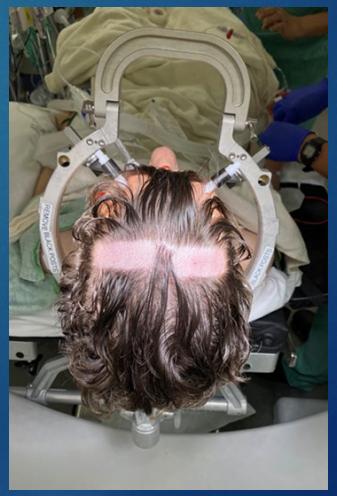
Operating Room:

Arterial Line or ClearSight Noninvasive continuous hemodynamic monitoring

Urine catheter inserted

Hair sparing approach

Anesthesia: awake v asleep



Awake v Asleep Cases

- Awake
  - Traditional approach
  - Propofol used for sedation during Burr hole and equipment set up.
  - Patient is awake during MER/intraop test stim then sedated again for closing
  - Benefits:
    - MER not impacted by anesthesia
    - Evaluate benefits/ side effects in real time
    - Preferred in tremor cases
  - Cons:
    - Stressful for patient
    - Labile blood pressure increases surgical risks
    - Time consuming
- Asleep
  - Pt under GA for entire procedure
  - Benefits:
    - Less stressful for patient
    - Surgical duration is more predictable
    - Improved airway and bp control
    - Preferred in cases with dystonia, epilepsy, severe anxiety and/or OSA
  - Cons:
    - Anesthesia can impact MER
    - Less ability to evaluate potential side effects/ benefits

DBS Surgery

Microelectrode Recording:

- Neurophysiologist (Dr. Jie Zheng) advances microelectrode and records neuronal activity during passive and active (if awake) movements

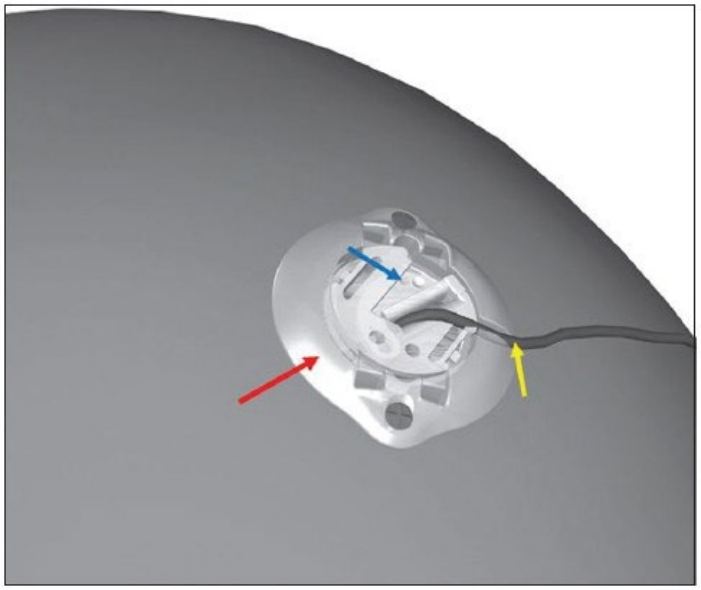
Test Stimulation:

- Evaluate symptom control and side effects, as appropriate
- If needed, we can adjust the positioning of the electrode at this time.
- Potential side effects: numbness, tingling, pulling, sensation of tightness, double vision or difficulty speaking.
  - A final portable CT scan will be obtained to confirm placement.
  - If awake, once placement is confirmed, patient may be sedated again

Final Steps…

- Completing the surgery:
  - The small hole(s) in your skull will be closed holding the lead firmly in place
  - A plastic cap covers the hole to keep it sealed
  - Your scalp incision(s) will be closed
  - The headframe will be removed
  - The urine catheter will be removed

- Recovery:
  - Your family and friends can see you once you are awake
  - You will be admitted to our neuro unit for a 1-night hospitalization and discharged after a post-op MRI is completed



Neurologyindia.com, 2015

Stage 2: Extension and Battery Placement

- May be same day or 1-2 weeks after the lead(s) is/are placed
- This is an outpatient procedure
- You will be asleep (general anesthesia) for this surgery
- Most people find this 2nd procedure more taxing than the actual brain surgery

Post-Surgery Care

Wound Care

- **Burr Hole/Connector Sites**:
  - Bandages remain in place for 24 to 48 hours post-op
  - Stitches removed 7-10 days after surgery.
- **Pin sites** (where the head frame was attached):
    - Ice packs help to decrease swelling and discomfort
- **IPG (battery) site(s):**
  - Closed internally and covered with steri-strips externally.

Bathing

- Keep incisions dry x 3 days (no showers)
- No long steamy showers or hot tubs for 6-8 weeks.
- Recommend using baby shampoo for first 1-2 weeks.

Symptoms

- Normal symptoms: swelling and minor bruising at the pin sites, incisions, face, neck and/or chest which should resolve within 2 weeks post-op.
- Microlesion Effect: PD or ET symptoms may be temporarily relieved and will then return.

Reasons to contact our office

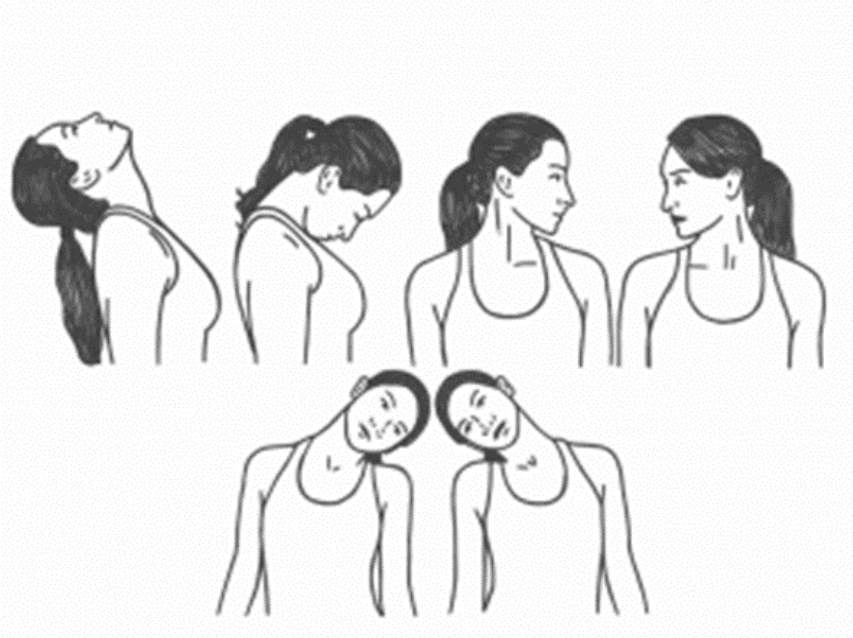
- **Incision**:
  - Bleeding or drainage
  - Increased tenderness, redness, puffiness
  - Separation of wound
- **Body symptoms:**
  - Fever or chills
  - Dizziness or lightheadedness that is new
  - Headaches not relieved by medication
- **Other:**
  - Weakness in limbs or facial muscles
  - Speech changes
  - Confusion or mentation changes

Complications

- If sudden and/or severe changes occur, do not hesitate to **call 911** or **go to the ER**.

Neck Range of Motion Exercises

- To limit scar tissue attaching to the extension wires causing a pulling sensation, practice daily GENTLE range of motion exercises to ensure maximum neck mobility post-surgery



Prehab Exercises, 2019, Retrieved from http://www.prehabexercises.com/eliminate-forward-head/

Post-Surgery Precautions

NO STOOPING, STRAINING, OR SQUATTING for 4 to 6 weeks: 20# weight limit; no gardening/ lifting weights/ running

Do not:

Drive for 2 weeks

Fly for 2 weeks

Avoid long car trips for 4-6 weeks

To reduce infection for 6-8 weeks after last surgery:

No swimming/ hot tubs

Avoid gyms

Defer dental procedures

Avoid hair coloring/ permanents

Avoid hair cuts with clippers

After 2 weeks, advance activity as tolerated

No sexual relations for 3-4 weeks

Pending occupation, take 4-8 weeks off

To reduce facial swelling, sleep on additional pillows

DBS Activation

Movement Disorders:

DBS activated 4 weeks after the implant date.

Parkinson disease: Hold PD meds day of initial programming

Optimum stimulation results can take 3-6 months of programming adjustments

Epilepsy:

- Programming adjustments will be made with Epilepsy specialist

Safety Concerns

It is safe to use household appliances, computers, and cell phones.

Metal detectors may be set off by stimulator and may turn off stimulator.

Purchase a medical id bracelet/necklace noting "Deep Brain Stimulator"

MRI: DBS is now FDA approved for full-body MRI in ***some*** circumstances

Some procedures will need to be modified for safety

Avoid procedures/ activities that may run a current through your body (arc welding, diathermy, lithotripsy etc)

Living with DBS

- Dentist: Prophylactic antibiotics not required
- EKG – turn off DBS prior to procedure
- CT, diagnostic ultrasound, x-ray, mammogram are safe
  - MRI conditional
- Monitor battery status regularly
  - Requires replacement approx. every 3-5 years
  - Rechargeable batteries last approx. 15 years
  - Battery replacement often done under sedation with local anesthetic

- **Visitors**:
  - Surgical waiting room: **2 symptom-free** visitors
  - Hospital: **2 symptom-free** visitors > 16 years of age per patient

Questions?

Call Laura Sperry, MSN, ANP-BC
DBS Program Director
916-734-3588