

# Deep Brain Stimulation Hardware-related Infections

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- I have unrelated grants from CDC & AHRQ
- I have an unrelated grant from PDI

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- Brief history
- Patient's perspective
- What is a DBS?
- Complications
- Infections
- Treatment of infections
- Prevention of infections

- FDA Approved to treat:
  - Essential Tremor (1997); ventral intermediate nucleus of the thalamus (Vim)
  - Parkinson's disease (2002); subthalamic nucleus (STN)
  - Dystonia (2003); globus pallidus interna (GPi)
  - Epilepsy (2018)
- Other uses (HDE, investigational)
  - Obsessive compulsive disorder
  - Tourette's
  - Depression
  - Alzheimer's

# A Patient's Experience

## Deep brain stimulation surgery helps Parkinson's patient get her life back to normal



Linda Stambaugh, at her floral shop in Lewistown, Illinois.

After she was diagnosed with Parkinson's disease, Linda Stambaugh of Browning, Illinois, saw her life slide downhill.

Parkinson's is a progressive disease, which means the early symptoms can be mild, but over time they get worse. As Linda's Parkinson's progressed, her tremors, falls, and other symptoms became more serious and forced her to leave her job as a corrections officer. Medications weren't helping her. Eventually, she became dependent on others for nearly everything.

"I couldn't function properly," she says. "I couldn't walk without help. I couldn't drive for a year. My husband or one of my children had to help me do anything or take me anywhere I needed to go."

### Locations & Contact



#### University of Iowa Hospitals & Clinics

200 Hawkins Drive  
Iowa City, IA 52242

#### Deep Brain Stimulation (DBS)

- **Neurology Clinic - Deep Brain Stimulation**  
Elevator E, Level 2  
1-319-384-8008, 1-800-322-8442

#### Parkinson's Disease

- **Neurology Clinic - Parkinson's Disease**  
Elevator E, Level 2  
1-319-356-2580

# A Patient's Experience



“When I first saw Linda in clinic, she shook so violently that she had difficulty doing even the simplest tasks, such as writing her name,” Thomsen says. “Walking was difficult for her due to slowness and stiffness. Medications just weren’t controlling the symptoms. She needed help to get back her quality of life. The best option that we could offer her was DBS surgery.”



Jeremy Greenlee,  
Neurosurgeon

“DBS is not a cure,” Greenlee says, “but it’s one tool to manage the symptoms. If the Parkinson’s gets worse over time, the beauty of DBS is that Dr. Thomsen can just turn up the stimulation to improve symptom relief.”

# A Patient's Experience

- Linda had surgery in 2011, performed by UI neurosurgeon Jeremy Greenlee, MD. Within weeks, she was independent again. She could drive. She returned to work, operating a floral shop with a friend.
- “You have to have that kind of support,” Linda says. “But I don’t sugarcoat it for them. I tell them the surgery hurt. And not everyone has the same outcome that I had. But I also tell them that two or three weeks after the surgery, I said, ‘I’d do that a million times if I knew I’d get the outcome I have now!’”





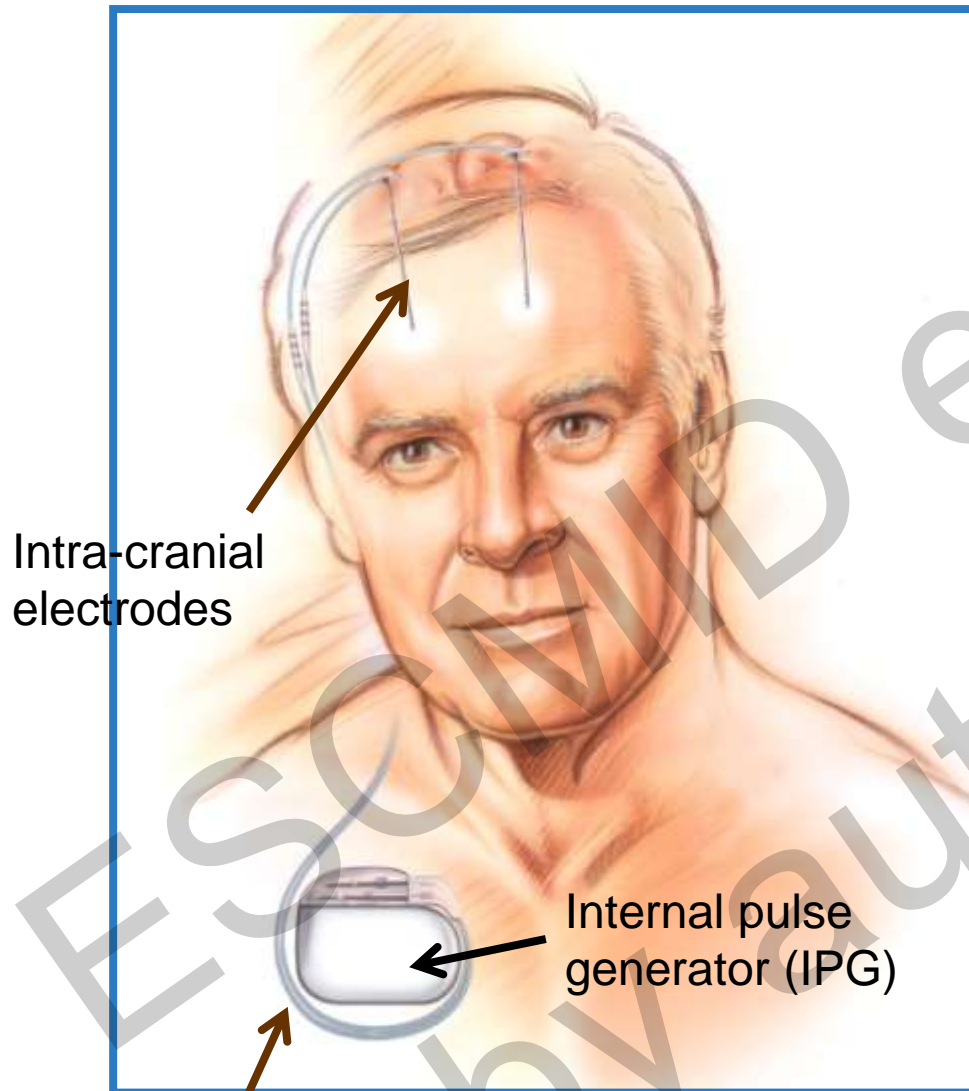
# DBS Implantation

- Usually done during 2 procedures
- First procedure:
  - Stereotactic implantation of brain electrodes
  - Awake or asleep
- Second procedure:
  - Implantation of extension wires & IPG
  - General anesthesia

# DBS Hardware



Devices cost \$18,000-\$30,000



Subcutaneous wire extensions



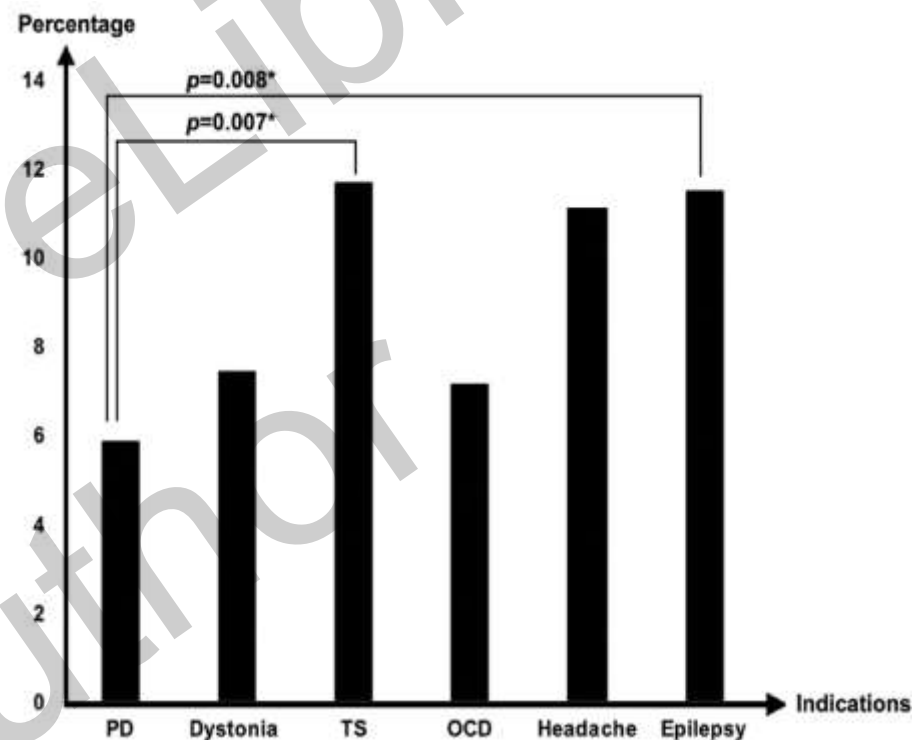


# DBS Complications

- Infection
- Mechanical problems
  - Disconnection, broken wire, etc
- Lead malposition
- Continued symptoms / progressive disease
- Hemorrhage
- Anesthesia complications

# DBS Complications

- Lead migration: 1.6%
- Lead fracture: 1.46%
- Failure of lead/other implant parts: 0.73%
- Skin erosions w/o infections 0.48%



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# DBS Complications

- Infection: 5.1% of pts
  - IPG pocket most common site: 27.5%
  - Extension cable at post-auricular area or along extension cable: 15.7%
  - Scalp area: 9.1%
  - Burr hole (intracranial leads entry): 7.5%
- Organisms
  - *S. aureus*: 20.0%
  - *S. epidermidis*: 3.7%
  - Coagulase-negative staph (CoNS): 2.4%
  - Skin flora 2.6%

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- Range 0-22%
- SSI rates are difficult to interpret
  - Definitions vary; some do not include a definition
  - Most do not describe surveillance methods
  - Duration of follow up varies
  - Denominators vary: pts, procedures, electrodes
  - Infection sites vary
  - SSI depths vary: superficial + hardware vs. hardware only
  - Some include infections associated w/ erosions

J Pepper, et al. J Neurosurg 2017;126:1165-72

KA Sillay, et al. Neurosurg 2008;62:360-7



M Sun Kim, et al. J Neurological Sci 2017;383:135-41



Pustule at the burr hole



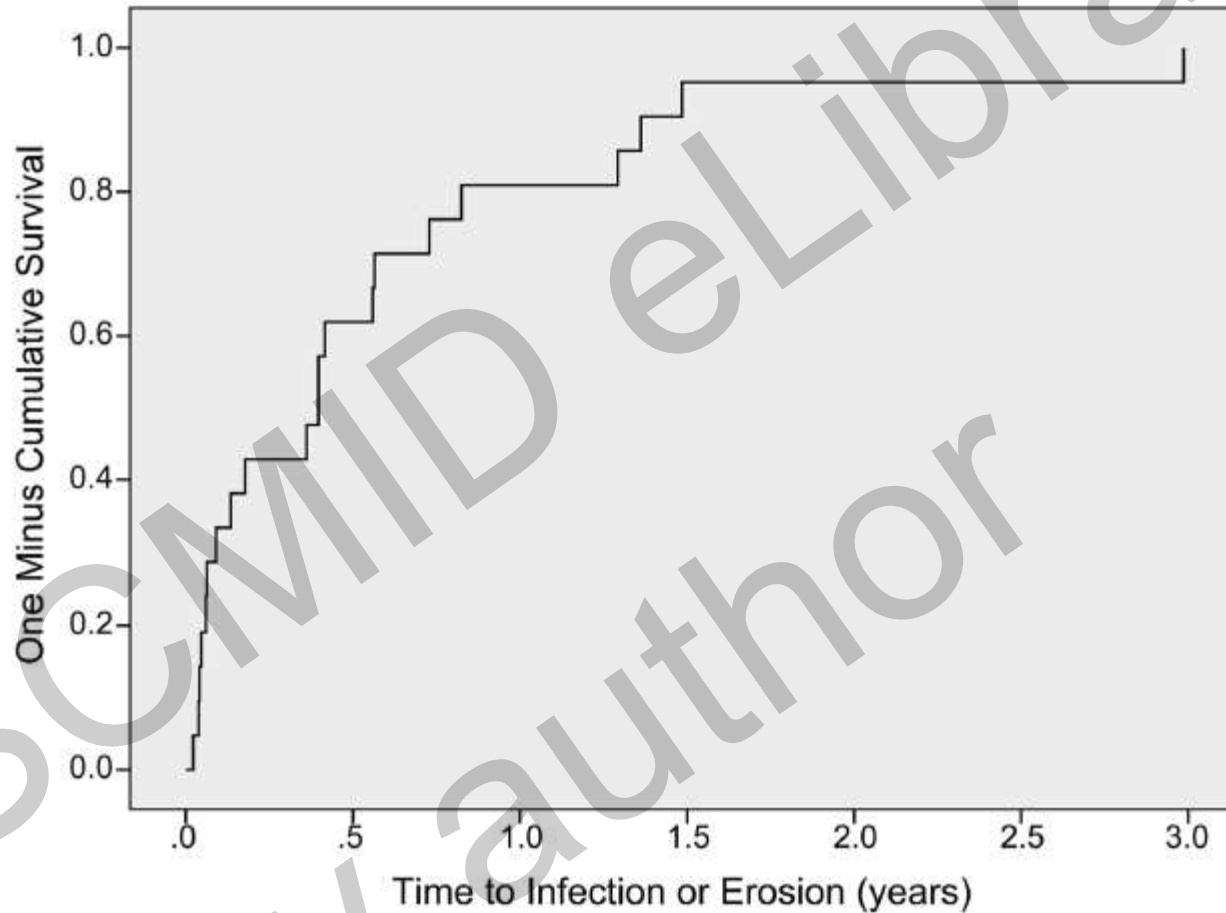
Erosion exposing the cap over a burr hole

## Rates of SSI & Erosions:

- Year 1: 17/443 (3.8%); 17/21 (81%)
- Years 1-2: 20/443 (4.5%)
- Years 1-3: 21/443 (4.7)
- Median time to:
  - SSI: 33 d (range 8-152)
  - Erosions: 387 d (range 206-1090)

FA Hardaway, et al. Neurosurg 2018;83:540-6

# Time to Infection or Erosion



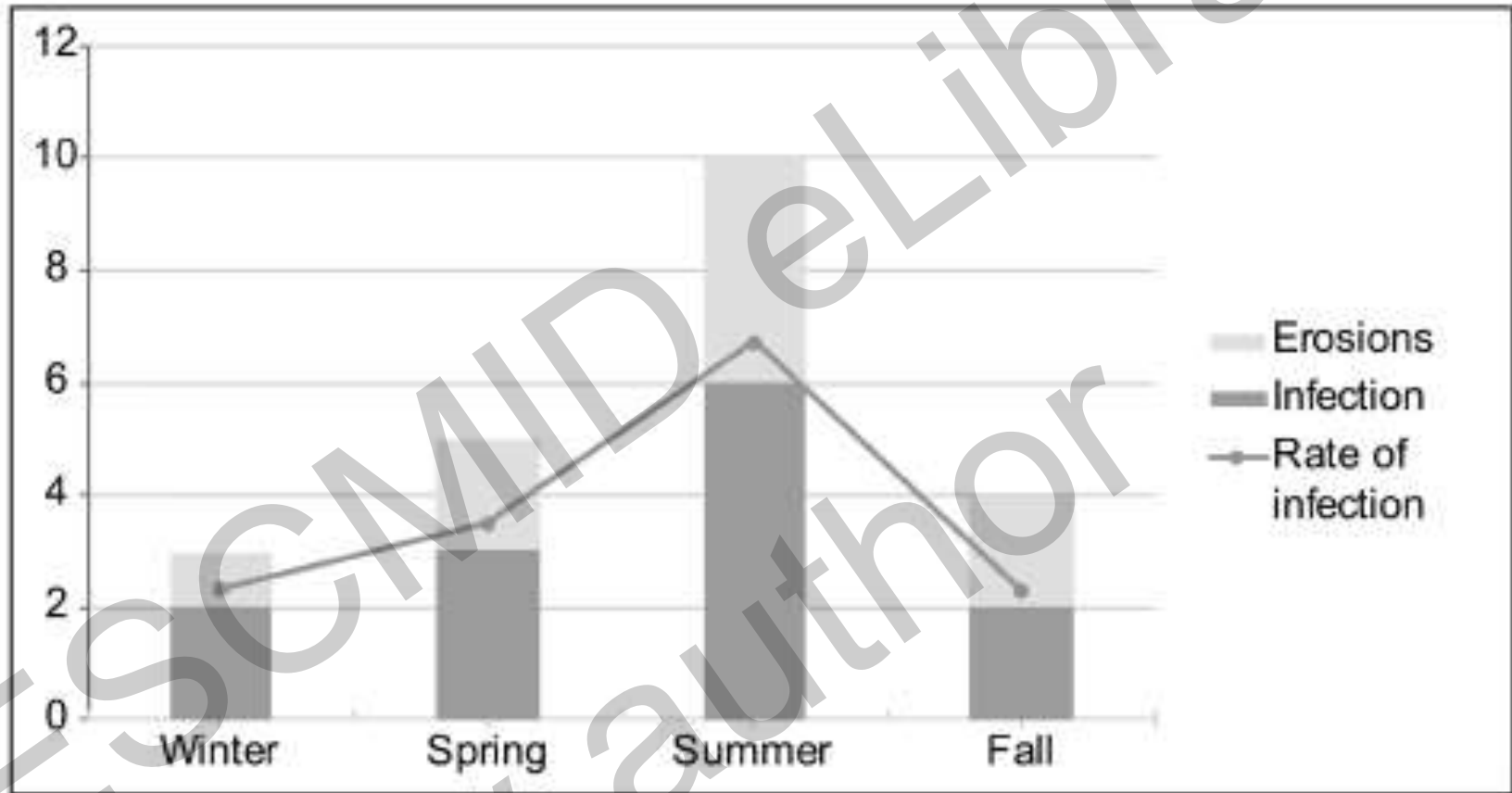
FA Hardaway, et al. Neurosurg 2018;83:540-6

# Infections & Erosions

- Infection: 13
  - MSSA: 3 (23.1%)
  - MRSA: 3 (23.1%)
  - *P. aeruginosa* + *C. acnes*: 1
  - CoNS, *C. acnes*, CoNS + *C. acnes*: 6
- Erosion: 8
  - CoNS, *C. acnes*, CoNS + *C. acnes*: 7
  - CoNS + *C. acnes* + *E. corrodens*,  
*S. lugdunensis*: 1

FA Hardaway, et al. Neurosurg 2018;83:540-6

# Possible Seasonality



FA Hardaway, et al. Neurosurg 2018;83:540-6

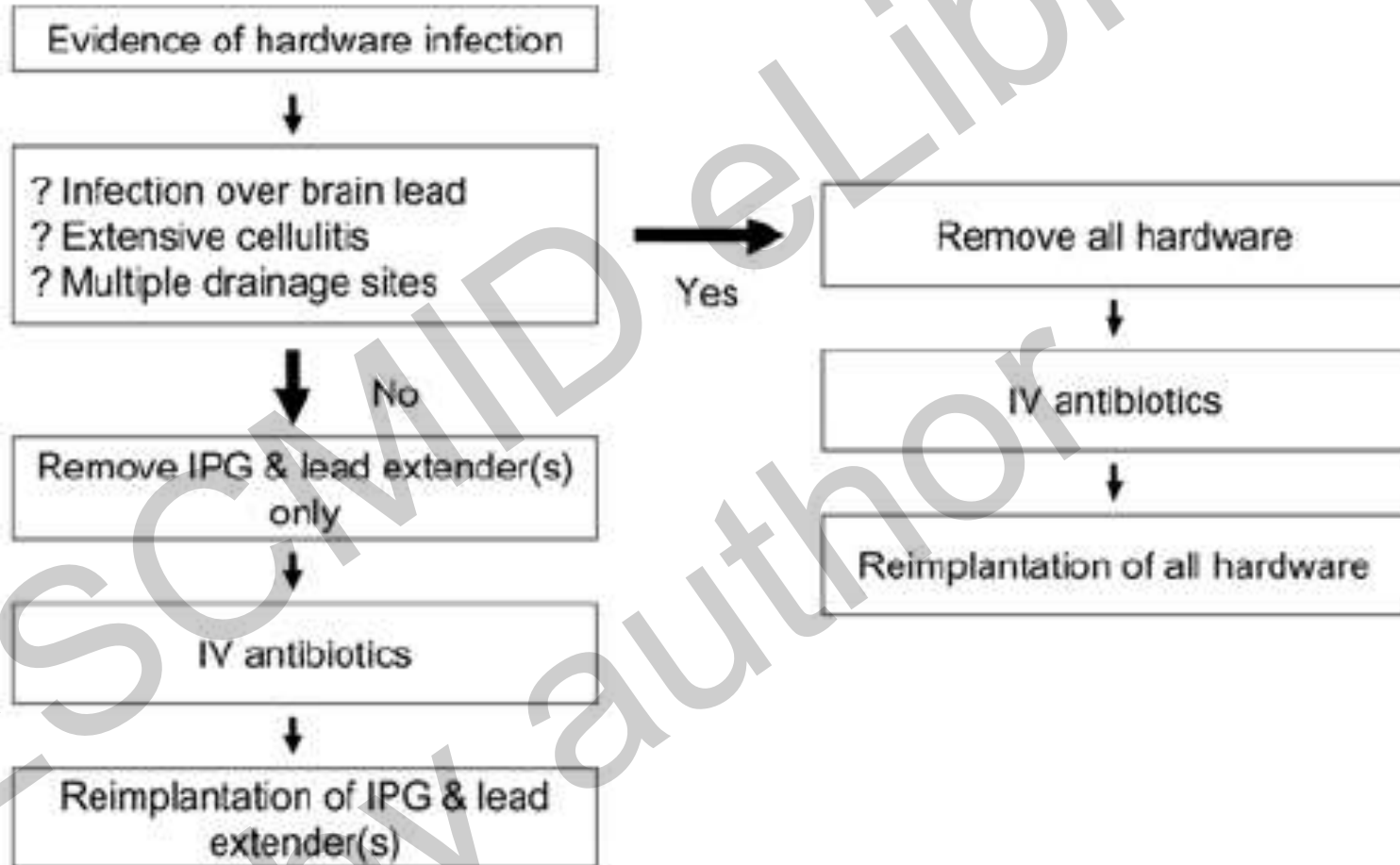


# Risk Factors for SSI

- Risk factors are not well defined.
- Risk factors vary by study.

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# Infection management algorithm

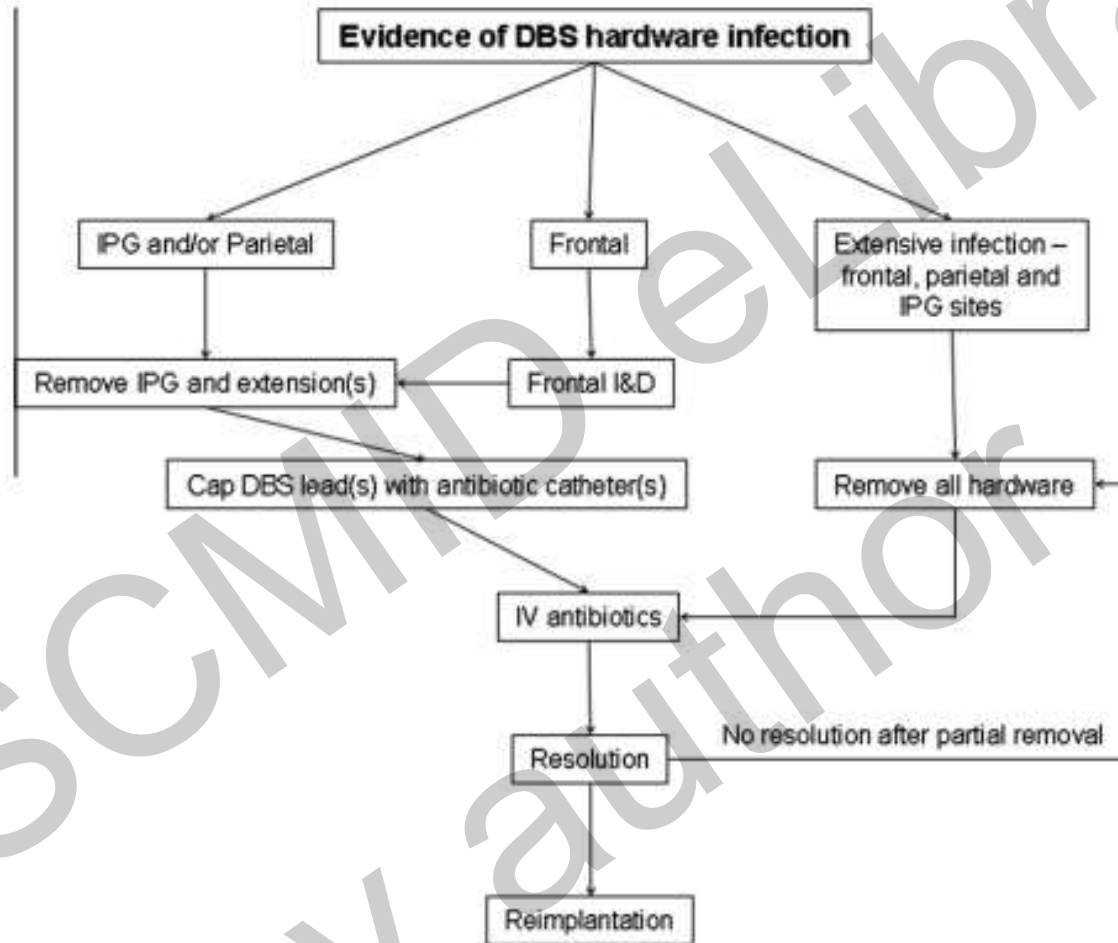


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## Successful Rx w/ partial hardware removal

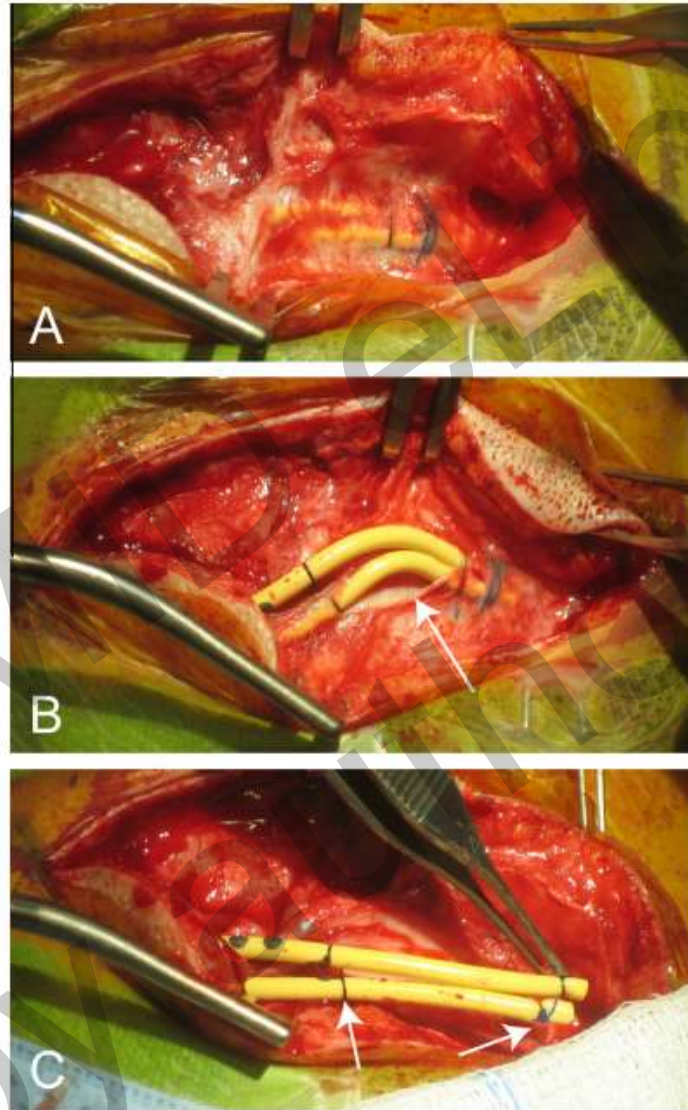
- *S. aureus*: 2/11 (18.2%)
- *C. acnes*, *S. epidermidis*, skin flora, no growth, not available: 7/8 (87.5%)
- 2-tailed p 0.0055

KA Sillay Neurosurg 2008;62:360-7



BJ Dlouhy, et al. J Clin Neurosci 2012;19:1369-75

# Lead Preservation Technique



BJ Dlouhy, et al. J Clin Neurosci 2012;19:1369-75

- 9/100 (9%) of pts w/ SSI met criteria for partial hardware removal & catheter coverage of DBS leads' distal ends at parietal incision
- 8/9 patients were treated
- 7/8 (87.5%): purulent deep tissue SSI around hardware at the frontal, parietal, or chest incisions
- 7/8 (87.5%): DBS leads salvaged

BJ Dlouhy, et al. J Clin Neurosci 2012;19:1369-75

# DBS Complications



- Before:
  - 4% PVI soap the evening before & morning of the procedure
- After carriers received:
  - 2% mupirocin ointment intranasal 3 x daily x 5 d
  - 4% CHG showers x 5 d
- SSI
  - Before: 13/119 (10.9%)
  - After: 1/63 (1.6%);  $p = 0.04$ , RR 0.13, 95% CI 0.003-0.922

J Lefebvre, et al. J Hosp Infect 2017;95:144-7



- Before:
  - *S. aureus* 8/13 (61.5%)
  - *E. coli*, *Micrococcus* sp., & *C. acnes* 1 each, 2 unknown
- After:
  - *E. aerogenes*
- Study limitations
  - Study populations: multiple differences
  - Did not define SSI or who identified SSI
  - Did not use time series analysis

# Vancomycin Powder (VP)

- Rasouli & Kopell: 1 gm VP
  - 297 pts DBS procedures 9/2012-12/2015
  - 1 gram VP applied to incision
  - No complications identified
- Kochanski et al.: 1 gm VP
  - Pre: 5/159 (3.1%); 1 MSSA, 1 MSSA + *C. acnes*, 2 *S. epi*, 1 *S. marcescens* + *C. acnes*
  - Post: 1/260 (0.38%); MSSA

JJ Rasouli & BH Kopell. World Neurosurg 2016;95:9-13

RB Kochanski, et al. Operative Neurosurg 2018;15:584-8

# Decolonization + Vancomycin Rinse

- Pts having IPG replacement
- Pre: 11/2002-12/2011; 80 pts, 94 IPGs
- Post: 1/2012-12/2014; 91 pts, 101 IPGs
  - MRSA screening
  - MRSA “eradication:” CHG body wash x 6 d, CHG hair wash QOD x 5 d, intranasal mupirocin 2% TID x 5 d
  - IPG pocket rinsed w/ vanco (20 mL of 1 mg/mL)
- Pre: 8 SSI; 7.5%/pt or 8.5%/procedure
- Post: 0 SSI;  $p = 0.0002$
- Limitation: did not do time series analysis

J Pepper et al. J Neurosurg 2017;1165-72

# Red Man Syndrome after VP



Y Nagahama, et al. J Clin Neurosci 2018;50:149-50

# Retrospective Cohort Study

- 464 electrodes, 242 adult patients, 245 primary procedures in ~10.5 years
- NHSN SSI definition w/ 90 d & 1 yr surveillance
- Periop prophylaxis
  - 1/1/05-31/5/11 pts w/o PCN allergies: nafcillin.
  - 1/6/11: cefazolin
  - Pts w/ PCN allergies: vancomycin (V) or clindamycin
  - 1/3/12 pts w/o V allergy received ~200–400 mg V powder (VP) in their incisions
  - *S. aureus* carriers were to receive intranasal mupirocin bid x 5 d & CHG bathing x 5 d

# Retrospective Cohort Study

- 90 d: 9 SSIs/245 procedures (3.7%)
- 1 yr: 16 SSIs (6.5%)
- Organisms
  - 6/16 (37.5%) MSSA +/- other organisms
  - 7 (43.8%) *C. acnes* +/- other organisms; 1 *S. lugdunensis*
  - 3 GNR (18.8%) (*C. acnes* + *P. aeruginosa*, *C. acnes* + *E. cloacae*, *S. marcescens*)

KO Abode-Kingsley, et al. J Neurosurg 2018;130:629-38

# Retrospective Cohort Study

- Total hardware removal: 1 *S. marcescens*
- Lead preservation:
  - Successful: 3—2 MSSA only, 1 GPC
  - Unsuccessful: 3—1 MSSA + *C. acnes* (CA), 1 CA + *P. aeruginosa*, 1 CA + *E. cloacae*
- No hardware removal:
  - Successful: 8 (50%): 2 MSSA only, 1 MSSA + ? *Diphtheroids*, 1 CA, 1 CA + ? *Diphtheroids*, 1 CA + *S. lugdunensis*, 1 MR *S. epi*, 1 skin flora
  - Unsuccessful: 1 CA + MR CoNS + *S. epi*

KO Abode-Kingsley, et al. J Neurosurg 2018;130:629-38

# Retrospective Cohort Study

- VP & SSI
  - 4/121 (3.3%) pts w/ VP
  - 12/124 (9.7%) w/o VP; adj OR 0.32, 95% CI 0.10–1.03,  $p = 0.06$
- Males vs. females: OR 0.28, 95% CI 0.10–0.80,  $p = 0.01$
- Dehiscence: OR 14.9, 95% CI 3.5-62.9
- 0/17 pts who received vanco for periop prophylaxis acquired SSI

KO Abode-Kingsley, et al. J Neurosurg 2018;130:629-38



# Summary & Conclusions

- DBS can change patients' lives
- DBS use is increasing & indications are expanding
- Hardware-related complications & infections
  - Are not uncommon
  - Can severely affect patients' lives & their ability to function
  - Have significant direct & indirect costs for patients

# Summary & Conclusions

- We need high quality multicenter studies to identify risk factors & preventive measures for SSI after DBS.
- Management of DBS SSI varies substantially.
- We need high quality multicenter studies to identify the best methods for treating these infections

**“Without the DBS  
there is no life.”**

Wife of a patient whose DBS was removed to treat an infection

# Acknowledgement



Thanks to Dr. Jeremy Greenlee for sharing slides & his expertise with me.

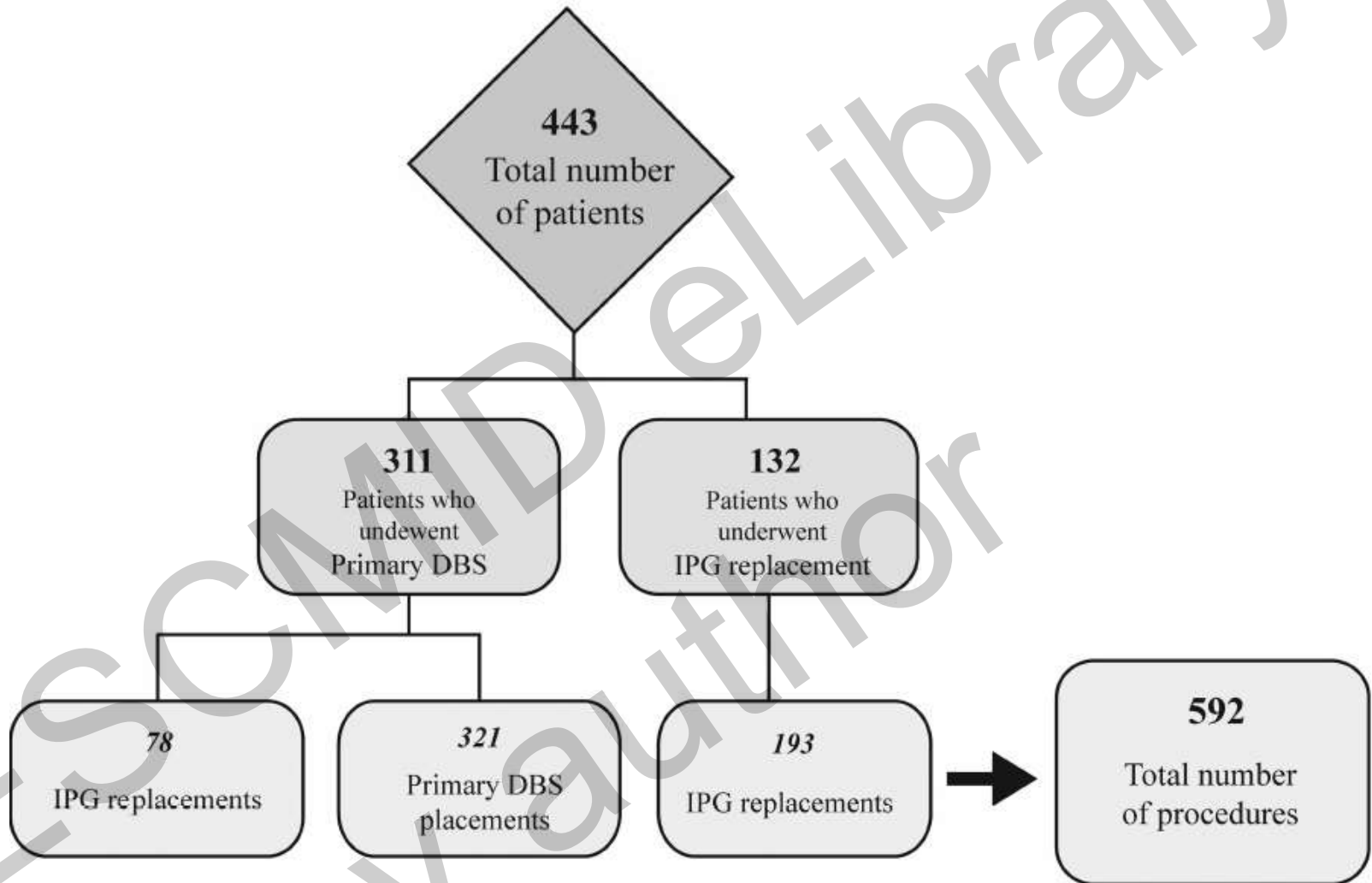
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Postoperative infections in patients undergoing a deep brain stimulation procedure during the periods before and after implementation of a regimen of preoperative *Staphylococcus aureus* screening and decolonization

	Screening group (N = 63)	Control group (N = 119)	P-value	Relative risk
Surgical site infection				
All bacteria	1 (1.6%)	13 (10.9%)	0.04	0.13 (0.003–0.922)
<i>S. aureus</i>	0	8 (6.7%)	—	—
Mean (±SD) time to onset (days)	33	49.3 (±68.8)	—	—
Site of infection				
IPG only	1	1	—	—
Wire extension only	0	1	—	—
Electrode only	0	1	—	—
IPG + wire extension	0	3	—	—
Wire extension + electrode	0	2	—	—
Diffuse	0	5	—	—
Grade of infection				
I	0	2	—	—
II	1	8	—	—
III	0	3	—	—

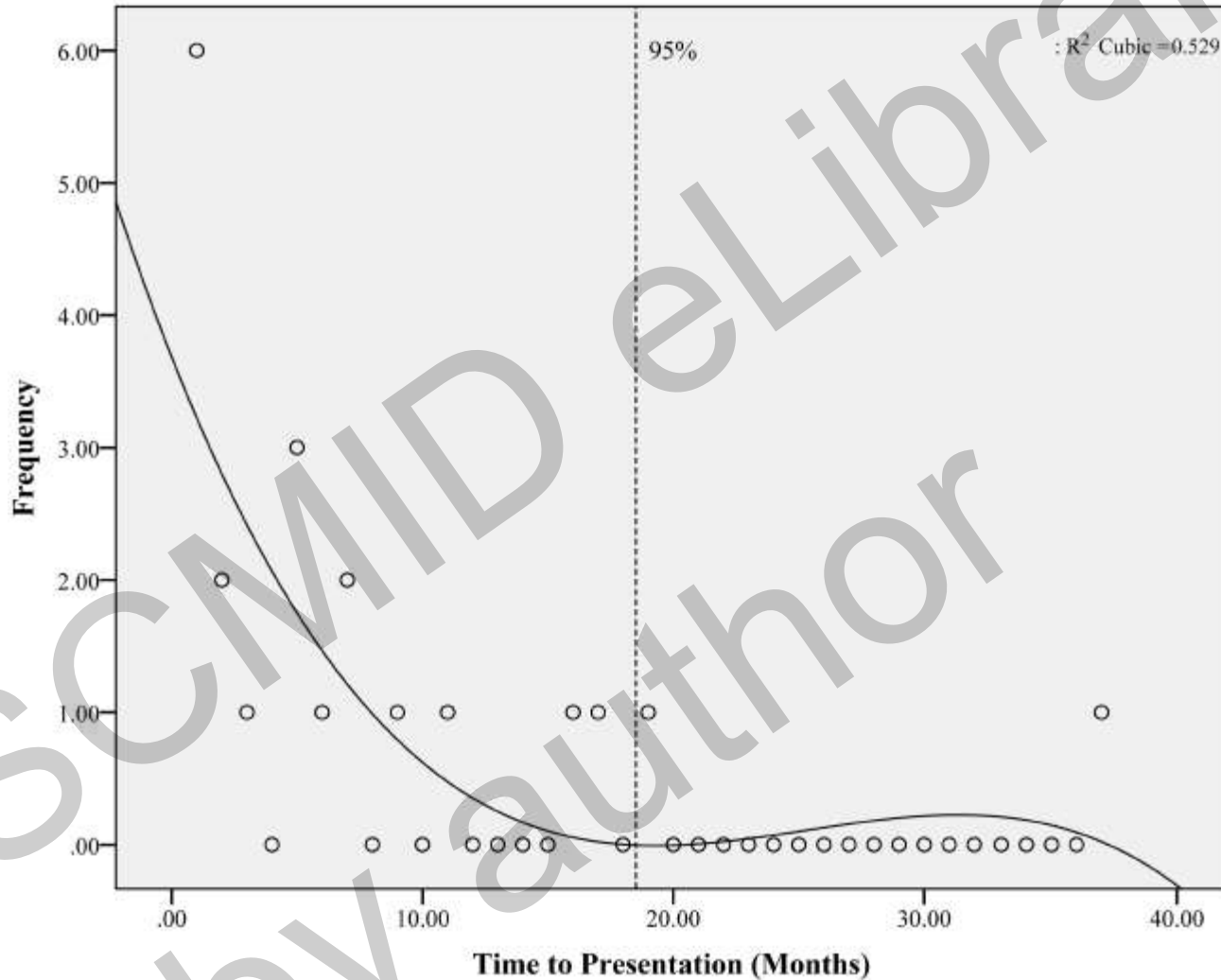
SD, standard deviation; IPG, internal pulse generator.

J Lefebvre, et al. J Hosp Infect 2017;95:144-7



FA Hardaway, et al. Neurosurg 2018;83:540-6

# Time to Presentation



FA Hardaway, et al. Neurosurg 2018;83:540-6