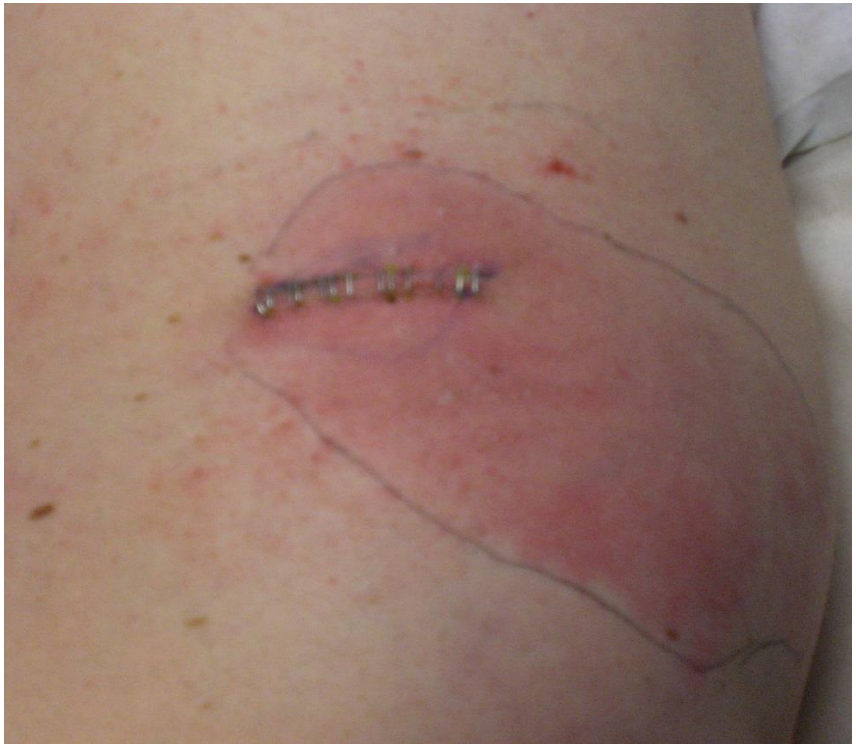
SCS: Infection Rates and Risk Factors



Salim M Hayek, MD, PhD
Professor, Dept of Anestheiology
Case Western Reserve University
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University Hospitals Case Medical Center

Complications

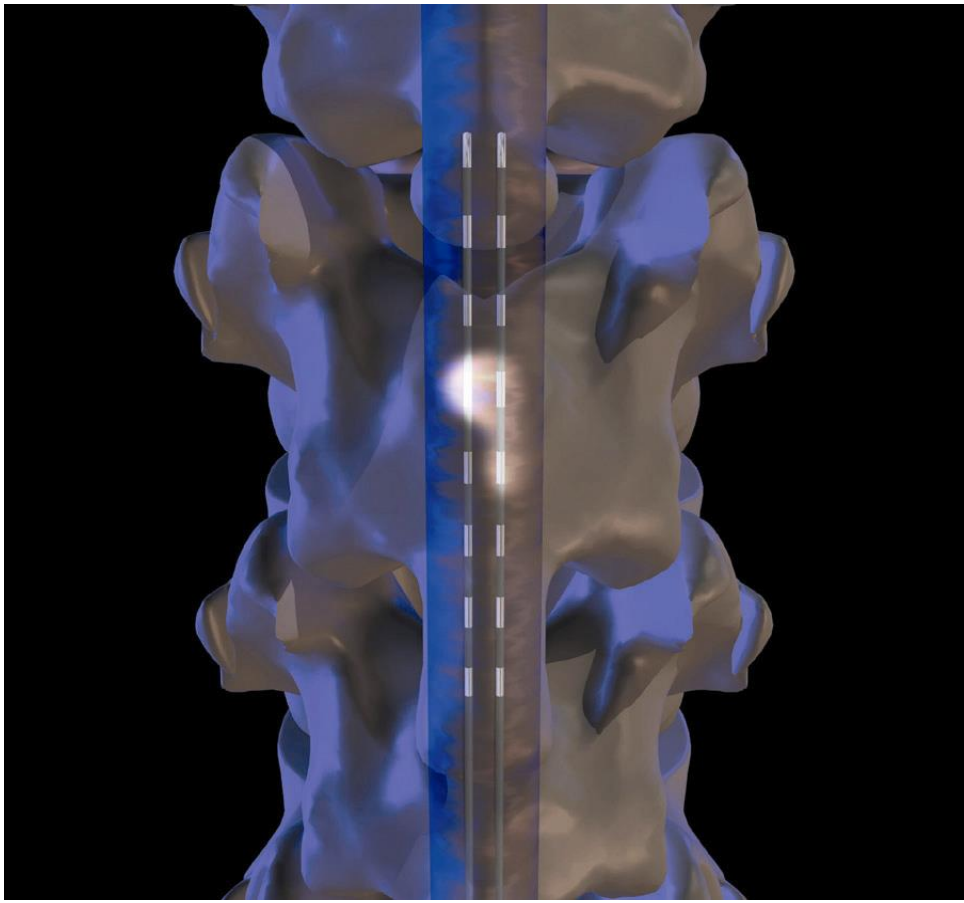
- We all get them

- "In surgery, a surgeon's experience can be measured by his complications but his wisdom is measured by how he deals with it"

  William Halsted

Complications of SCS

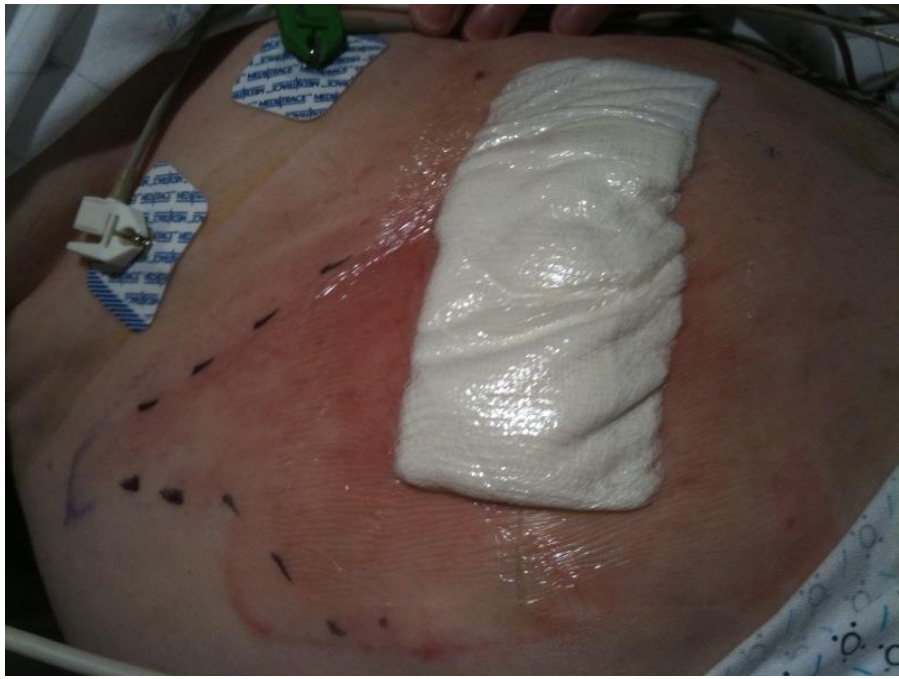
- Technical
- Biologic
- Other



Biologic Complications

Early Complications

- Hematoma
- Seroma
- Wound Separation
- Ischemia
- Infection



Late Complications

- Scars
- Keloids

Surgical Site Infections (SSIs)

- In the US:
  - 2nd most reported healthcare infection
  - ~500,000 SSIs/yr
    - 17% of all healthcare-associated infections
    - ↑ length of hospital stay by an average of 7.5 days
    - Cost: $10 billion dollars annually
- Implantable device SSI = an infection in the region of an implant within 1 yr post-op

Thompson KM et al., Chasing zero: the drive to eliminate surgical site infections. *Ann Surg* 2011;254:430-436

Surgical Site Infections

- ↑'d risk of SSI
  - Diabetes Mellitus HbA1c ≥7.0 %
  - Smoking
  - ↑ASA classification
  - Meds: steroids; ? high dose opioids
  - hypoalbuminemia (≤ 3.4 mg/dL)
  - anemia (Hgb ≤ 10 g/dL)
  - excessive alcohol use (not defined)
  - history of COPD or CHF
  - infection at remote site
  - current operation through a previous incision
  - suboptimal timing of prophylactic antibiotic therapy

Gaynes RP et al., Clin Infect Dis 2001;33(S2):S69-77
Hikata, T., et al. J Orthop Sci (2014) 19: 223
Haridas M, Malangoni MA. Surgery 2008;144:496-503

SSI

- Additional factors for ↑ risk of SSI
  - Wound classification
  - Immune compromised; Chemo; ~HIV
  - Inpatient stay for >48 h before surgery
  - Inpatient stay for >5days post-op
  - Patients colonized with Staphylococcus
  - Surgeon Competence
    - Surgical technique = risk factor
    - Duration of surgery >75th %le

Mishriki SF, Law DJ, Jeffery PJ. Factors affecting the incidence of postoperative wound infection. J Hosp Infect 1990;16:223e230.

Injury and Liability Associated with Implantable Devices for Chronic Pain

Anesthesiology 2016; 124:1384-93

Dermot R. Fitzgibbon, M.D., Linda S. Stephens, Ph.D., Karen L. Posner, Ph.D., Edward Michna, M.D., J.D., James P. Rathmell, M.D., Kelly A. Pollak, M.D., Karen B. Domino, M.D., M.P.H.

- Closed Claims 1990-2013; pain medicine
  - Implantable Device Procedures
    - IDDS (pumps)
    - Tunneled catheters
    - SCS
    - PNS
- 148 closed claims
  - 2 spasticity
  - 2 cancer pain
  - 144 CNCP

ASA's Closed Claims Project

	n (%)
Maintain IDDS (n = 41)	41 (28)
Surgical device procedures (n = 107)	
Implant IDDS	45 (30)
Implant spinal cord stimulators	42 (28)
Implant tunneled catheters	7 (5)
Implant peripheral stimulators	3 (2)
Remove IDDS	8 (5)
Remove spinal cord stimulators	1 (1)
Remove tunneled catheters	1 (1)

IDDS (n = 94, 64%) *vs.* SCS (n = 43, 29%)

Fitzgibbon DR et al., *Anesthesiology* 2016; 124:1384-93

ASA's Closed Claims Project

- 107 surgical-related damaging events from Implanted Devices (148 total)
  - **infections** (23%, n = 25) # 1 complication
    - 3 major infection complications
      - finger amputation
      - severe brain damage
      - death
    - 7/25 identified infections were related to intended or unintended retention of foreign bodies (e.g., sponges, SCS leads)

Fitzgibbon DR et al., *Anesthesiology* 2016; 124:1384-93

J Neurosurg (Spine 3) 100:254–267, 2004

Safety and efficacy of spinal cord stimulation for the treatment of chronic pain: a 20-year literature review

TRACY CAMERON, PH.D.

Complication	Number of events	Total number of patients	Rate of occurrence (%)
Technical complications			
Lead migration	361	2753	13.2
Lead breakage	250	2753	9.1
Hardware malfunction	80	2753	2.9
Battery failure	35	2107	1.6
Loose connection	12	2753	0.4
Biologic (postsurgical) complications			
Infection	100	2972	3.4
Cerebrospinal fluid leak	8	2972	0.3
Hematoma	8	2972	0.3
Other complications			
Undesirable stimulation	65	2753	2.4
Pain over implant	24	2753	0.9
Skin erosion	1	2753	0.2
Allergic reaction	3	2753	0.1
Other	38	2753	1.4

Spinal Cord Stimulation INFECTIONS

Publication/Type of Study/Period of Follow-up	Therapy Type	N	Rate (%)
Hayek et al. 2015 Retrospective review; 12 to 44.5 months	SCS	234	4.3
Kumar et al. 2006 Retrospective analysis; 22-year experience	SCS	410	3.4
Engle et al. 2013 Retrospective study in cancer pain patients	SCS	59	3.4
Mekhail et al. 2011 Retrospective analysis; consecutive pts 2000 to 2005	SCS	527	4.5
Al-Kaisy et al. 2014 Prospective, multicentre study; 24 months	HF-10 SCS	72	6
Van Buyten et al. 2013 Prospective, multicentre European study; 6 months	HF-10 SCS	72	4.8
Kemler et al. 2004 / RCT	SCS (CRPS)	24	4
Kumar et al. 2008 / RCT; 24 months	SCS	42	10
North et al. 2005 / RCT; up to 3 years postimplantation	SCS	45	6
Taylor et al. 2006 Systematic review; 2 years post-intervention	SCS (CRPS)	554	4
Taylor et al. 2005 Systematic review; 1 to 120 months	SCS (FBSS)	3427	6
Turner 2004 Systematic review; mean follow-up 1 to 60 months	SCS	830	4.6

Center for Disease Control and Prevention

Recommendations for Perioperative Infections

- Recommendation Rankings
  - **IA**: Strongly recommended for implementation and supported by well-designed experimental, clinical, or epidemiological studies
  - **IB**: Strongly recommended for implementation and supported by some experimental, clinical, or epidemiological studies and strong theoretical rationale
  - **II**: Suggested for implementation and supported by suggestive clinical or epidemiological studies or theoretical rationale

Mangram AJ et al., Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol* 1999;20:250-278

CDC RECOMMENDATIONS--SSI	Evidence Rankings
Preoperative Measures	
Optimize glucose control	IB
Discontinue tobacco use	IB
If hair is removed, use electric clippers immediately before surgery	IA
Use prophylactic antibiotic therapy	IA
Vancomycin should not be used routinely	IB
Intraoperative Measures	
Use appropriate preparation technique and agent selection for skin antisepsis	IB
Maintain positive pressure ventilation in the operating room (OR)	IB
Keep the OR doors closed during procedure	IB
Limit OR traffic	II
Handle tissue gently and eradicate dead space	IB
Postoperative Measures	
Use occlusive sterile dressing for 4-48 hours postoperatively	IB
If a dressing change is required, use: Hand washing Sterile technique	IB II

International Survey 506 Physicians

- Only 4/15 recommended practices had compliance rates ≥80% (CDC, NICE, and SCIP)
  - utilization of perioperative antibiotics
  - appropriate timing for antibiotic administration
  - postoperative application of an occlusive dressing
- High levels of noncompliance:
  - weight-based antibiotic dosing
  - hair removal strategies
  - double gloving, surgical dressing
  - skin antiseptic agent selection
  - postoperative continuation of antibiotics

Provenzano DA et al., Neuromodulation. 2016 Jan;19(1):71-84

Real Life Retrospective Analysis

Anesthesiology 2004; 100:1582–94

Prevention and Management of Intrathecal Drug Delivery and Spinal Cord Stimulation System Infections

Kenneth A. Follett, M.D., Ph.D., Richard L. Boortz-Marx, M.D.,† James M. Drake, F.R.C.S.(C.),‡ Stuart DuPen, M.D.,§ Steven J. Schneider, M.D., F.A.C.S., F.A.A.P.,‖ Michael S. Turner, M.D.,# Robert J. Coffey, M.D.***

- Unpublished clinical study data
- Postmarket & medical device reporting data
- Published meta-analyses
- CDC guidelines
- Other publications

Follett KA et al., Anesthesiology 100: 1582-1594, 2004

SCS post-market data 9/1/2000-7/1/2002

Device models	Power source: IPG: 106/93% RF coupled: 8/7%
Indication	
Noncancer pain	114/100%
Cancer pain	—
Spasticity	—
Not reported	—
Perioperative antibiotics	
Antibiotics used	99/87%
Antibiotics not used	1/1%
Unknown or not reported	14/12%
Infected sites or components	
Pocket (IPG or pump)	61/54%
Tract (lead or catheter)	19/17%
Lumbar site	9/8%
Multiple sites	16/14%
Other, or site not reported	9/8%
Any site plus meningitis	—
Bacterial cultures	
Cultures performed	95/83%
Cultures not performed	5/4%
Unknown or not reported	14/12%

Follett KA et al., Anesthesiology 100: 1582-1594, 2004

SCS Infection Details

Culture results	
Staphylococcus species	46/48%
Pseudomonas species	3/3%
Multiple or other species	6/6%
No growth	17/18%
Unknown or not reported	23/24%
Antibiotic treatment	
Intravenous	46/40%
Oral	18/16%
Intravenous and oral	45/39%
Not reported	5/4%
Device explantation	
Total	94/82%
Partial	14/12%
Not explanted	4/4%
Not reported	2/2%
Interval: implantation to explantation, range, months	1–104
≤ 1 month	43/38%
≤ 2 months	21/18%
> 2 months	39/34%
Device not explanted	1/1%
Interval not reported	10/9%
No. of risk factors*	
Zero	71/62%
One	34/30%
Two	7/6%
Three or more	2/2%
Outcome	
Resolved, no complications	104/91%
Resolved, drug withdrawal	—
Event ongoing at time of report	3/3%
Death (cause)	—
Outcome not reported	7/6%

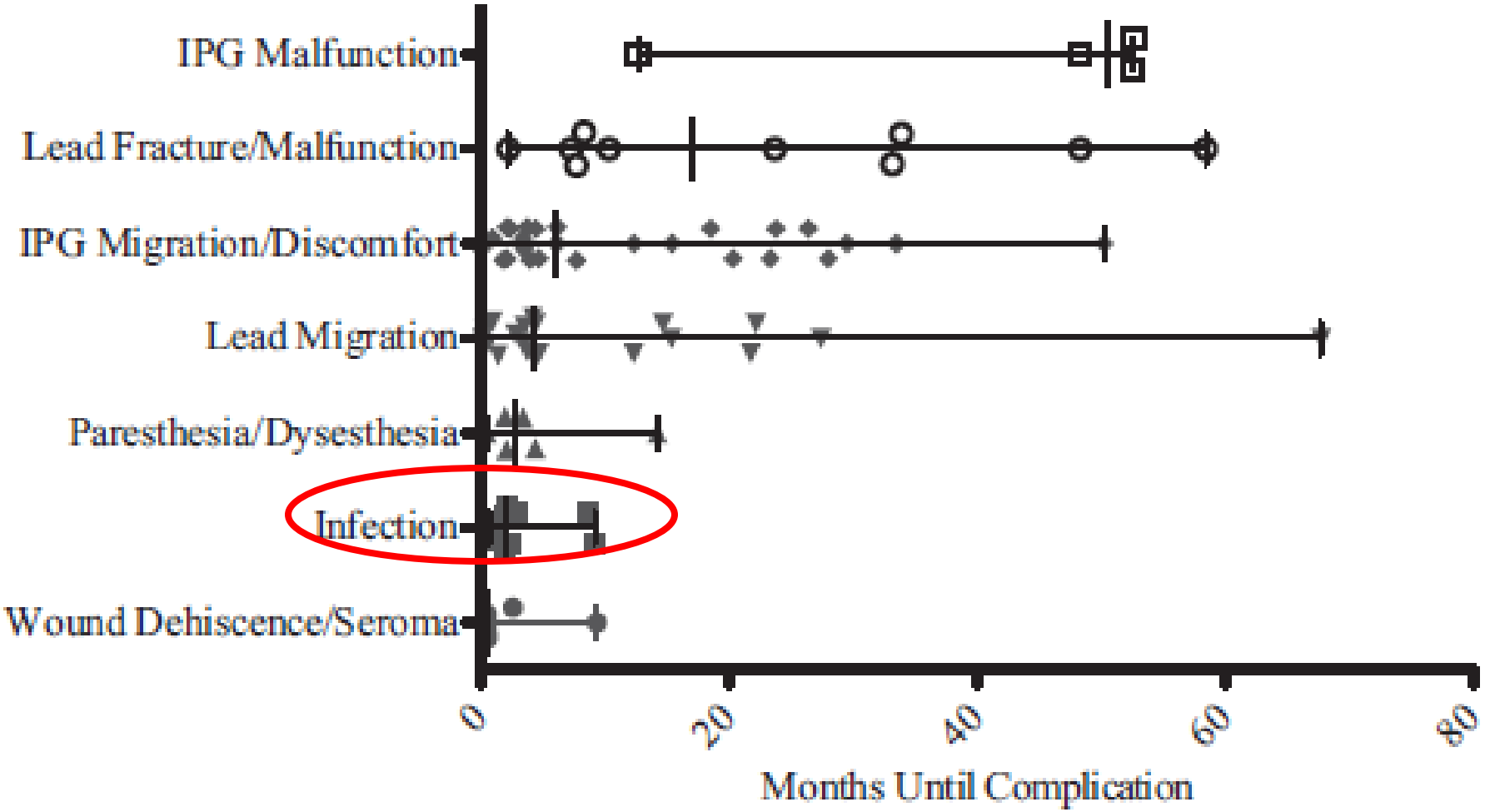
diabetes, debilitated status, malnutrition, extremely thin body habitus, obesity, autoimmune disorder, corticosteroid use, decubitus ulcers, preexisting infection, poor hygiene, urinary or fecal incontinence, and malabsorption syndrome

Outcomes

- 56% of infections were explanted within the first 2-months after implant
  - 38% at 1 month
  - 18% at 1–2 months
  - 34% at >2 months
- 91% of SCS cases experienced successful resolution of their infections
- Only 1% not explanted
- No patients died

Follett KA et al., Anesthesiology 100: 1582-1594, 2004

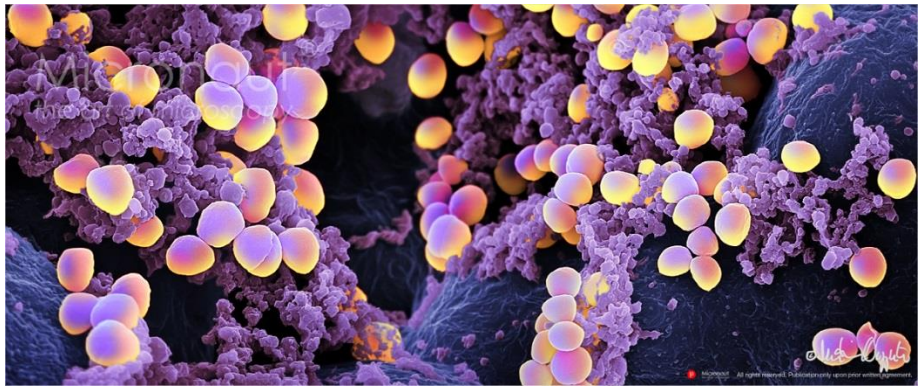
Timeline of Complications



Hayek SM, Veizi IE, Hanes M, Neuromodulation. 2015 Oct;18(7):603-9

Significantly

- IPG pocket site: most common SSI
- Non-relevant: Implanter specialty
  - Anesthesiologist
  - Neurosurgeon
- Staph spp.
  - 48% of infected cases
  - 84% of cases with positive culture
- Physicians decided to completely or partially remove infected SCS devices in 94% of cases



Follett KA et al., Anesthesiology 100: 1582-1594, 2004

Similar, More Recent Study

- 131 patients high-risk populations (80% of the study population had a dx of cancer)
  - 58% IDDS
  - 42% SCS
- Infection rate was 2.8%
  - All infections occurring at the site of the pulse generator or pump pocket
- Extended surgical time → a statistically significant risk factor for an SSI

Enlge MP et al., **Infectious complications related to intrathecal drug delivery system and spinal cord stimulator system implantations at a comprehensive cancer pain center.** *Pain Physician* 2013;16(3):251-257.

Preoperative Practices	Origin of Recommended Practice	Evidence Levels
Identify and treat all remote infections	CDC IA	II-2
Optimize glucose control for neuromodulation implants	CDC IB	II-2
Discontinue tobacco use for neuromodulation implants	CDC IB	II-2
Decolonize MSSA and MSRA carriers through the application of mupirocin nasal ointment and chlorohexidine baths		I
Utilize preoperative antibiotics	CDC IA and NICE	I
Utilize preoperative weight-based antibiotic dosing	CDC IA and NICE	I
Use appropriate preoperative timing (within 1 hour prior to surgical incision excluding vancomycin) of prophylactic antibiotic	CDC IA, NICE, SCIP	I
Remove hair (when required) with electric clippers immediately before the surgical procedure	CDC IA and NICE	I
Perform preoperative surgical scrub for a minimum of 2 to 5 min with an appropriate antiseptic	CDC IB and NICE	II-2
Keep nails short and do not wear artificial nails	CDC IB and NICE	II-3
Do not wear hand or arm jewelry	CDC IB and NICE	III

A Word about Mupirocin

- Orthopedic implants: nasal carriage of *S. aureus* was the most important risk factor for developing an SSI
- >80% of healthcare-associated *S. aureus* infections are endogenous
  - bacteria isolated from the infected areas matches the nares' 80% to 85% of the time
- ~25% to 30% of the general population is colonized with *S. aureus*
- Screen & treat with mupirocin →
  - ↓ SSI (60%) and ↓ hospital costs

Bode LG et al., Preventing surgical-site infections in nasal carriers of *Staphylococcus aureus*. *New Engl J Med* 2010;362:9-17.

A Word about Antibiotics

- Given within 1-hr from incision (except Vanco-120')
- Should be
  - Weight-based
  - Re-dosed based on
    - ½ life
    - duration of surgery
    - renal function

Antimicrobial	Recommen Adults[a]	Recommended Redosing Interval (From Initiation of Preoperative Dose), hr[c]
Ampicillin–sulbactam	3 g (ampicillin 2 g/sulbactam 1 g)	2
Ampicillin	2 g	2
Aztreonam	2 g	4
Cefazolin	2 g, 3 g for pts weighing ≥120 kg	4
Cefuroxime	1.5 g	4
Cefotaxime	1 g[d]	3
Cefoxitin	2 g	2
Cefotetan	2 g	6
Ceftriaxone	2 g[e]	NA
Ciprofloxacin[f]	400 mg	NA
Clindamycin	900 mg	6
Ertapenem	1 g	NA
Fluconazole	400 mg	NA
Gentamicin[g]	5 mg/kg based on dosing weight (single dose)	NA
Levofloxacin[f]	500 mg	NA
Metronidazole	500 mg	NA

Bratzler DW et al., Clinical practice guidelines for antimicrobial prophylaxis in surgery. *Am J Health Syst Pharm*. 2013 Feb 1;70(3):195-283.

NACC Guidelines

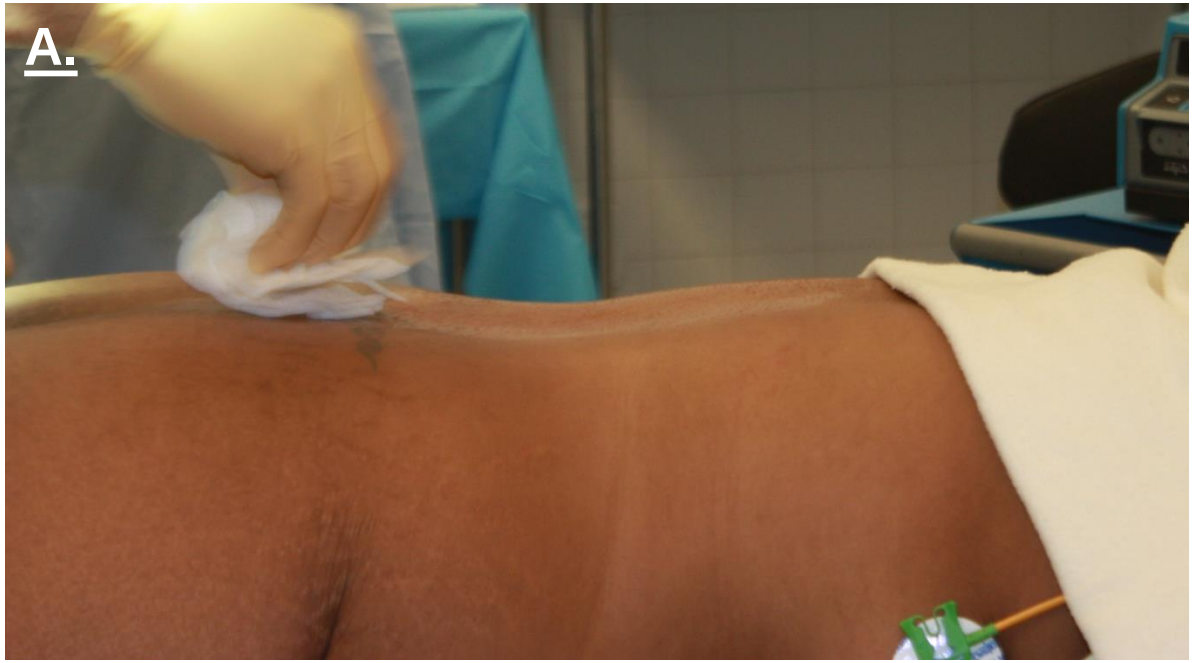
Antibiotic	Standard intravenous dosing	Timing prior to incision	Redosing interval	Indications
Cefazolin**	1 g ≤ 80 kg 2 g > 80 kg 3 g > 120 kg	Within 30–60 min	3–4 hours (CrCl > 50 mL/min) 8 hours (CrCl 20–50 mL/min) 16 hours (CrCl < 20 mL/min)	First-line
Clindamycin	600 mg ≤ 80 kg 900 mg > 80 kg 1200 mg > 120 kg	Within 30-60 min	6 hours (CrCl > 50 mL/min) 6 hours (CrCl 20-50 mL/min) 6 hours (CrCl < 20 mL/min)	β-lactam allergy
Vancomycin	1 g ≤ 80 kg 2 g > 80 kg 3 g > 120 kg	Within 120 min	8 hours (CrCl > 50 mL/min) 16 hours (CrCl 20-50 mL/min) None (CrCl < 20 mL/min)	β-lactam allergy Known MRSA colonization

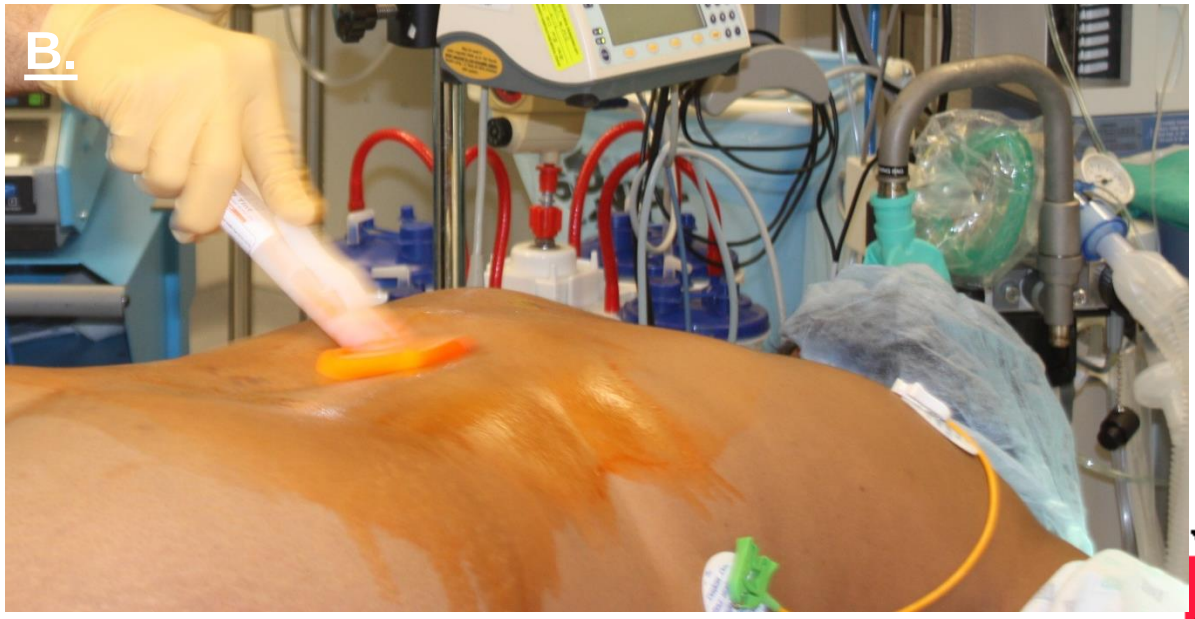
*Modified from Bratzler et al. (89), Alexander et al. (90), and Bratzler et al. (91).
**In an effort to simplify cefazolin weight-based dosing, the American Society of Health-System Pharmacists (ASHP) recommends 2 g for individuals weighing <120 kg and 3 g for individuals weighing ≥120 kg. MRSA, methicillin-resistant *S. aureus*; CrCl, creatinine clearance.

- Europe: Ceftriaxone/teicoplanin (MRSA) used in place of Cefazolin/Vancomycin

Deer TR et al., **The Neurostimulation Appropriateness Consensus Committee (NACC) Recommendations for Infection Prevention and Management.** *Neuromodulation* 2017; 20: 31–50

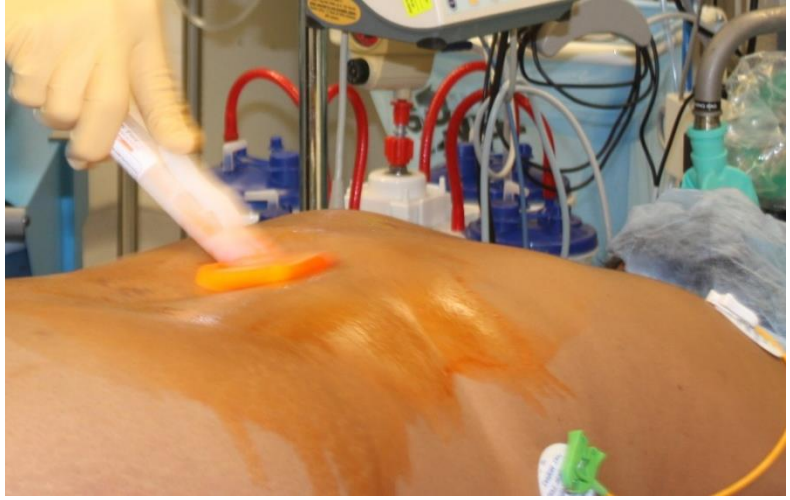
Prevention
Intra-op





Intraoperative Practices for neuromodulation trials and implants		
Wear a surgical mask/cap/sterile gown/gloves	CDC IB	II-3
Double glove	CDC II and NICE	II-1
Utilize chlorhexidine gluconate for preoperative skin antiseptic agent	CDC IB and NICE	I
If an incise drape is used, then use iodophor-impregnated drape	NICE	I
Use laminar flow and HEPA filters in OR for neuromodulation implants	CDC IB	I
Limit procedure room traffic	CDC II and NICE	I
Keep procedure room doors closed during	CDC IB	II-3
Limit tissue trauma, maintain hemostasis, eradicate dead space, and avoid electrocautery at tissue surface	CDC IB and NICE	III
Irrigate with saline through a bulb syringe prior to closure of wound		I
Employ implant strategies to limit operative time		II-2

A Word about Chlorhexidine



- Chlorhexidine more effective than Povidone Iodine skin prep at ↓ bacterial count
- Chlorhexidine bathing + mupirocin → preoperative decolonization of patients
  - *S. aureus* infection
    - 3.4% (17/504 pts) in the mupirocin-chlorhexidine grp
    - 7.7% (32 of 413 patients) in the placebo group
    - Effect most pronounced on deep infection

Bode LG et al., Preventing surgical-site infections in nasal carriers of *Staphylococcus aureus*. *New Engl J Med* 2010;362:9-17.

Postoperative Practices

Apply an occlusive dressing following neuromodulation trials and implants for 24 to 48 hours	CDC IB and NICE	II-2
Do not routinely use topical antimicrobial agents for surgical wounds that are healing by primary intention	NICE	I
Understand maximum time criterion for defining a deep surgical site infection of an implantable device (1 year postimplant)	CDC	III
Do not continue antibiotics into the postoperative period for neuromodulation trials and implants beyond 24 hours	SCIP	I
Educate patient and family on proper incision care, symptoms of SSI, and importance of reporting symptoms	CDC II and NICE	III
Wash hands before and after dressing changes	CDC IB	III
Use sterile technique for dressing changes	CDC II and NICE	III
When SSI is suspected, prescribe an antibiotic that covers the likely causative organisms. Consider local resistance patterns and culture results in choosing an antibiotic	NICE	III

Device SSI Definitions

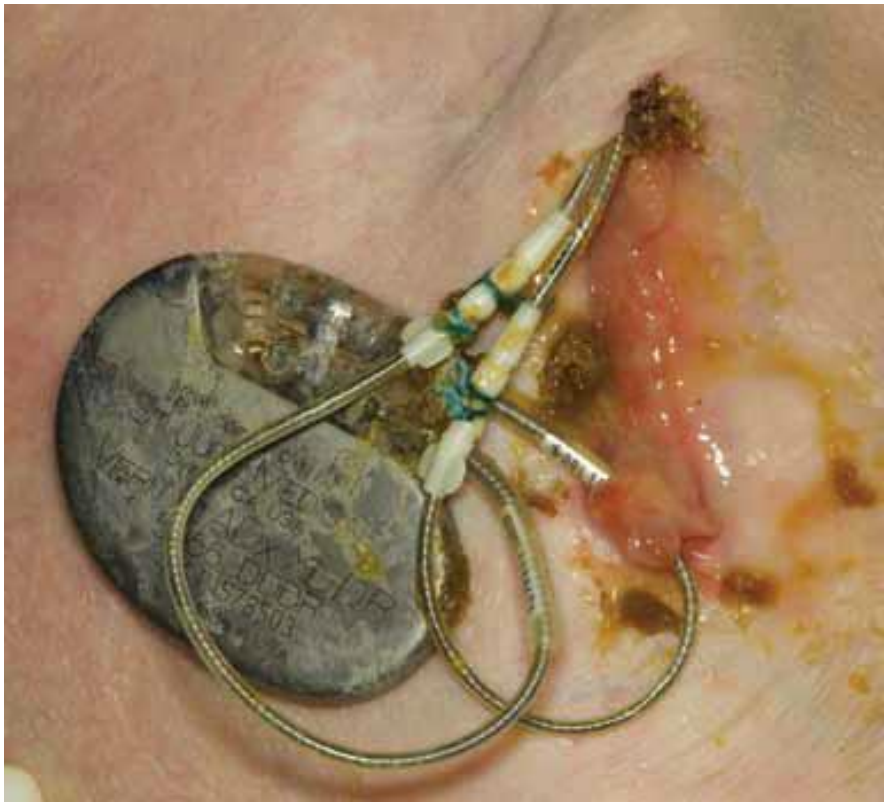
- Superficial SSIs → the skin and S/Q tissue surrounding the incision
  - defined as infections occurring within 30 days after the operation
- Deep SSIs → the deep soft tissue including muscle and fascia
  - timeframe: up to 1 year postoperatively

Centers for Disease Control and Prevention. *Guideline for Prevention of Surgical Site Infection, 1999*.
http://www.cdc.gov/hicpac/pdf/SSIguidelines.pdf

Cardiac Experience

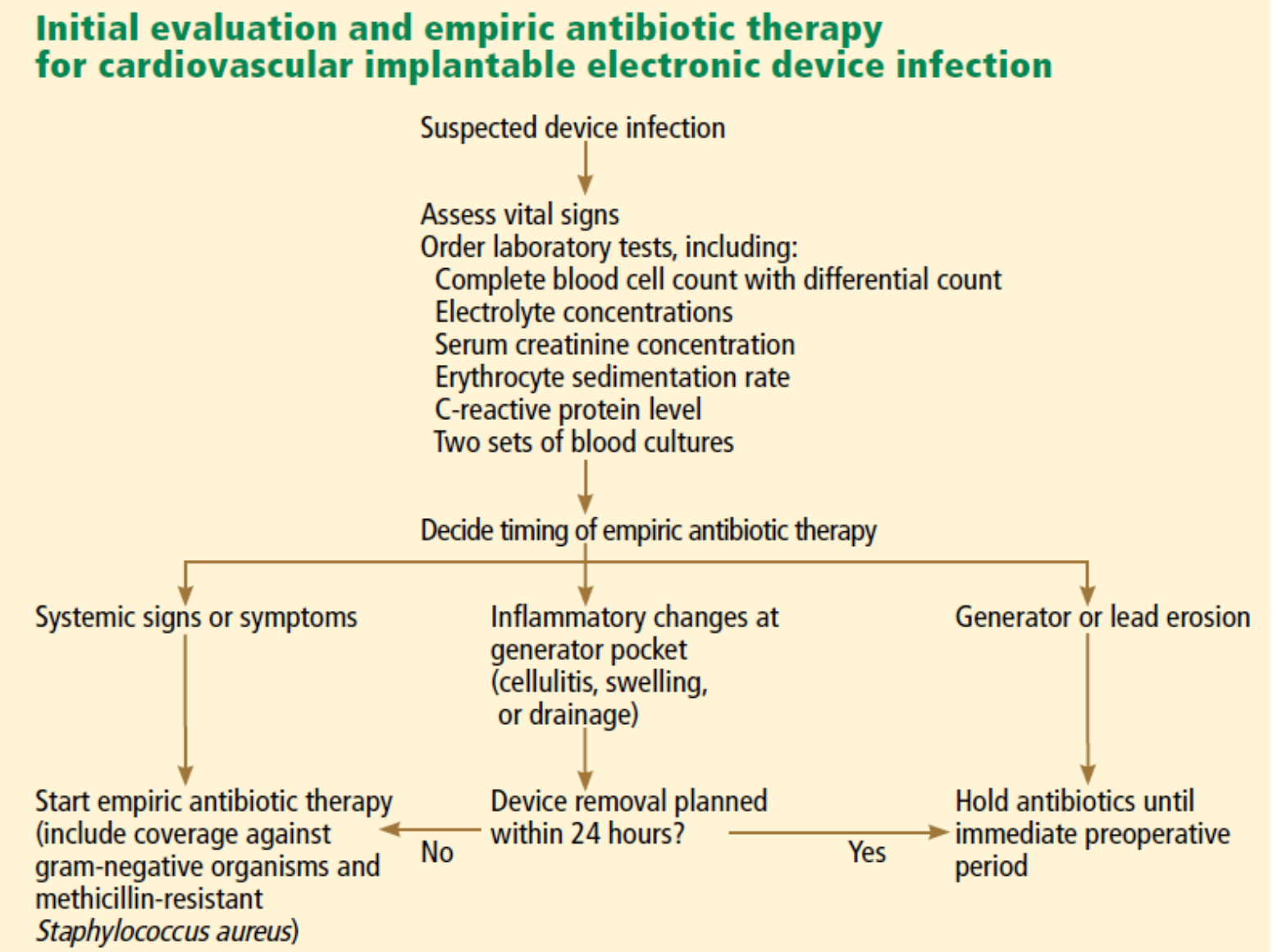
Cardiovascular implantable electronic device infection: A stepwise approach to diagnosis and management

- **Should the device be removed?** Superficial infection of the wound or incision site (e.g. stitch abscess) early after implantation can be managed by conservative antibiotic therapy without removing the device. However, complete removal is necessary in all other presentations



Dababneh AS, Sohail MR, Cleve. Clin. J. Med. 2011 Aug;78(8):529-37

CIED Algorithm



How to manage an Infected SCS?

- The gold standard in treating deep SCS infections is a 2-stage procedure:
  - the initial stage involves removal of implanted material, wound debridement, and antibiotic treatment
    - ID consult
  - After wound healing has occurred and no infection imminent, re-implantation can be performed (usually ≥ 6 wks)

Can SCS be Salvaged?

- SCS Leads → epidural space
- IPG is by far the most expensive SCS component
- No case reports of keeping generator in an open incision after I&D
- Distinguish superficial *vs.* deep SSI (biofilm)
- Attempts at salvaging SCS in the setting of SSI should be made only in the setting of:
  - Complete patient understanding of potential risks
  - Close follow up by implanter and ID specialist
  - Careful serial monitoring of patient
    - Clinically
    - Laboratory values such as CRP

Treatment of Infection

- Incision & Drainage of abscess
- Copious irrigation
  - Solution for pollution is dilution
- Prevention of
  - Hematoma
  - Ischemia
- Primary closure? clinical judgment
- Antibiotics

summary
overview
brief
synopsis
recap
outline
digest
text
study
outcome
teacher
solution
teaching
meeting
agreement
condensed
resume
seminar
decision
explaining
workshop
professional
finance
idea
success
teamwork
writing
business
presentation
employee
explanation
compendium
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people
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conceptual
concept
management
discussion
word
conclusion
review
schedule
message
introduction
adult
corporate
succinct
work
topic
write
compact
extract
school
plan
statistics
concise
advice
analysis
human
information
education
collaboration
cooperation
consulting
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strategy
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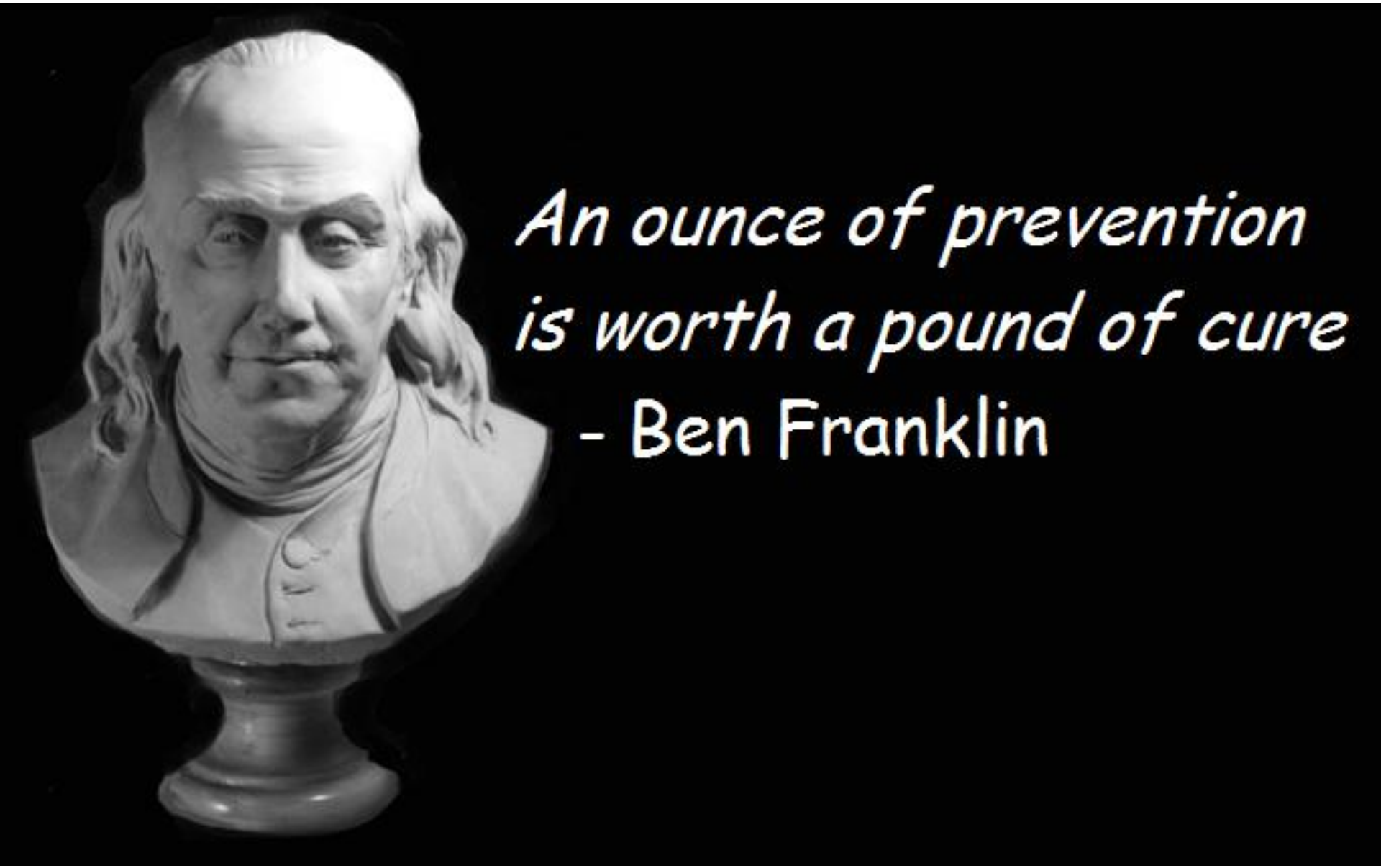
short


An ounce of prevention
is worth a pound of cure
- Ben Franklin

Prevention—Pre-operative

1) Control Diabetes (HbA1c < 7%)
2) Smoking cessation (min. 4 wks)
3) Limit/eliminate pre-op steroids
4) Treat any infection (skin, tooth…)
5) Optimize nutritional status in frail
6) HIV: consider Inf. Dis. Consult
7) Cancer/Chemo: Consult Oncologist
8) Optimize coagulation status
9) Staph colonized? Mupirocin/chlorhexidine
10) Weight-based Abx within 1-hr of incision

Deer TR et al., **The Neurostimulation Appropriateness Consensus Committee (NACC) Recommendations for Infection Prevention and Management.** *Neuromodulation* 2017; 20: 31–50

Prevention—Intra-operative

1) Need shave? Electric clippers in OR
2) Hand scrub: minimum 2-5 minutes
3) Surgical prep: Isopropyl alcohol then Chlorhexidine
4) Surgical cap, mask, sterile gloves[2]/gowns
5) Laminar flow/PPV/HEPA filter OR ↓ infection
6) Minimize # OR personnel and traffic
7) Minimize contact with C-arm drape and light handles
8) Iodophore-impregnated adhesive drape
9) Skilled surgeon/gentle tissue handling/expeditious
10) Bulb irrigation with saline and ? Antibiotic envelope (minocycline/rifampin) in high risk patients

Deer TR et al., **The Neurostimulation Appropriateness Consensus Committee (NACC) Recommendations for Infection Prevention and Management.** *Neuromodulation* 2017; 20: 31–50

Prevention—Post-operative

1) Occlusive dressing for 24-28 hrs
2) Antibiotic first 24 hrs
3) Follow up within 10 days
4) Educate family and patient
5) If deep infection →
    1) follow closely
    2) consult Infectious Disease
    3) consider neuraxial imaging if indicated

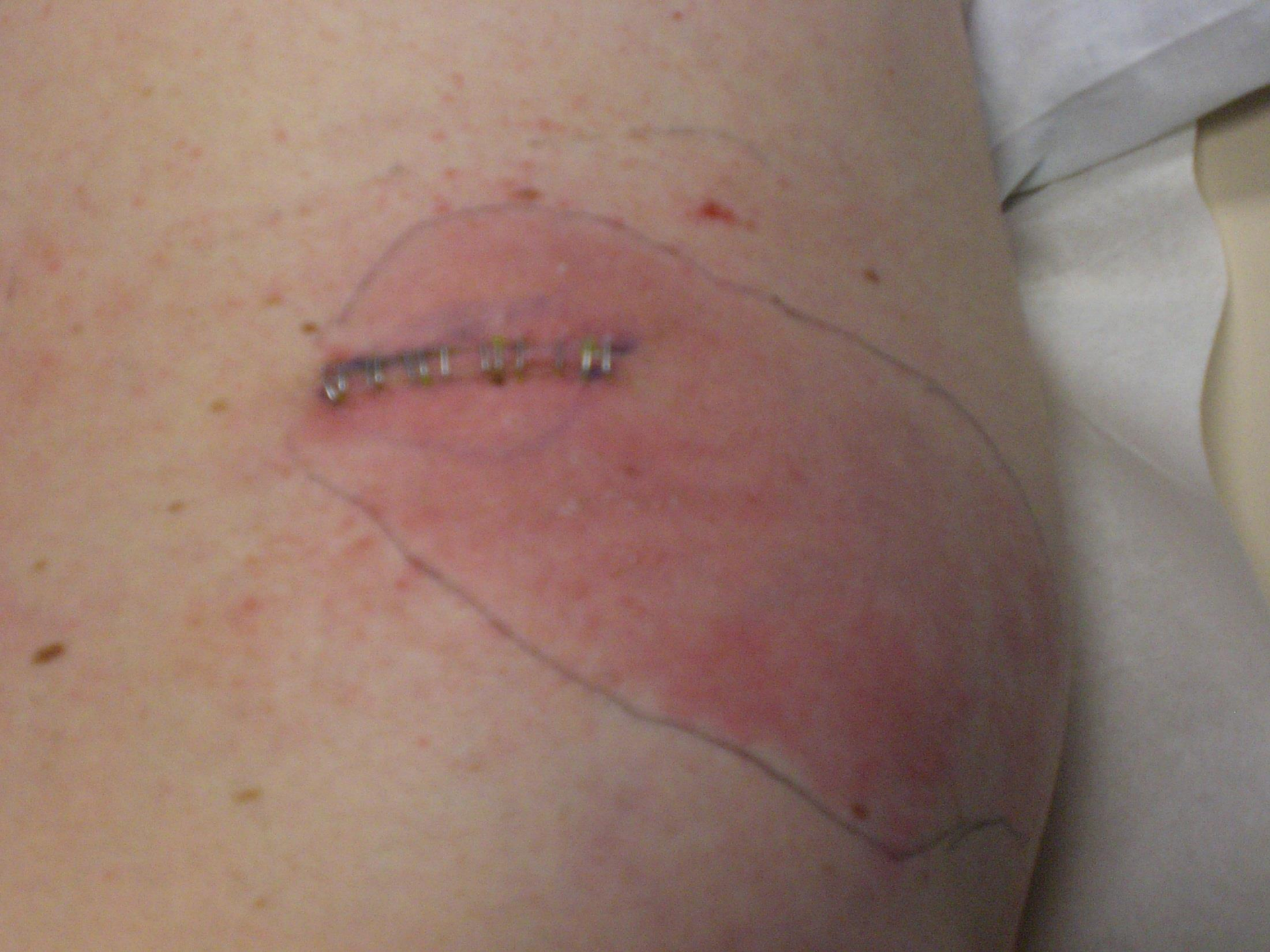
Deer TR et al., **The Neurostimulation Appropriateness Consensus Committee (NACC) Recommendations for Infection Prevention and Management.** *Neuromodulation* 2017; 20: 31-50

SCS SSI Conclusions

- Prevention is priceless:
  - Pre/intra/post-op optimization is essential
  - Surgical Skills: critical to good outcomes
- Infection →
  - superficial *vs.* deep
    - Deep: Explant + abx + drain
    - Superficial: may attempt salvage with abx
  - In case of uncertainty:
    - Follow clinically
    - Obtain serial markers (CRP)
  - Obtain an Inf. Dis. consult

Thank You!!

"Nurse, get on the internet, go to SCS .COM, scroll down and click on the 'Are you totally lost?' icon."



CDC/NICE/SCIP Recommendations

Recommended practice	Pertinent references and comments
Preoperative practices	
Utilization of preoperative antibiotics for SCS trials	Bowater et al. (19) demonstrated that antibiotic prophylaxis is effective for reducing the risk of wound infection for all types of surgery.
Utilization of preoperative weight-based antibiotic dosing for SCS trials	Weight-based dosing of antibiotics is required to achieve therapeutically effective drug concentrations (17,20).
Utilization of preoperative antibiotics for SCS implants	Bowater et al. (19) demonstrated that antibiotic prophylaxis is effective for reducing the risk of wound infection for all types of surgery.
Utilization of preoperative weight-based antibiotic dosing for SCS implants	Weight-based dosing of antibiotics is required to achieve therapeutically effective drug concentrations (17,20).
Appropriate preoperative timing (within one hour prior to surgical incision excluding vancomycin) of prophylactic antimicrobial administration for SCS implants	
Hair removal (when required) with electric clippers immediately before the surgical procedure	

Provenzano DA et al., Neuromodulation. 2016 Jan;19(1):71-84.

CDC/NICE/SCIP Recommendations

Intraoperative practices	Pertinent references and comments
Utilization of double gloving	Tanner and Parkinson (21) concluded that the addition of a second pair of surgical gloves reduces perforations to the innermost gloves. Although there is insufficient evidence that double gloving reduces the risk of SSIs. NICE recommends wearing two pairs of sterile gloves when there is a high risk of glove perforation and the consequences of contamination may be serious (7).
Utilization of chlorhexidine gluconate for preoperative skin antiseptic agent	CDC and NICE recommend the use of an appropriate antiseptic agent (povidone–iodine or chlorhexidine containing products). Darouiche et al. (22) demonstrated that preoperative skin preparation with chlorhexidine-alcohol is superior to povidone–iodine for preventing surgical site infection.

Provenzano DA et al., Neuromodulation. 2016 Jan;19(1):71-84.

CDC/NICE/SCIP Recommendations

Postoperative practices	Pertinent references and comments
Application of an occlusive dressing following a spinal cord stimulator trial	CDC recommends applying a sterile dressing for 24–48 hours postoperatively (category IB). NICE recommends interactive dressings. Hutchinson and McGuckin demonstrate lower rates of infection with occlusive dressings (23).
Application of an occlusive dressing following a spinal cord stimulator implant	CDC recommends applying a sterile dressing for 24–48 hours postoperatively (category IB). NICE recommends interactive dressings. Hutchinson and McGuckin (23) demonstrate lower rates of infection with occlusive dressings.
Understanding maximum time criterion for defining a deep surgical site infection of an implantable device (one year)	Infection occurs within one year if an implant is in place and the infection appears related to the operation.
No continuation of antibiotics into the post-operative period for spinal cord stimulator trials beyond 24 hours*	SCIP recommends the discontinuation of antibiotics within 24 hours after surgery.
No continuation of antibiotics into the postoperative period for spinal cord stimulator implants beyond 24 hours†	SCIP recommends the discontinuation of antibiotics within 24 hours after surgery.

Provenzano DA et al., Neuromodulation. 2016 Jan;19(1):71-84.