Prevention Strategies for Device-Related Infections

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Objectives

1. To understand the principles and need for antimicrobial prophylaxis for implantable devices
2. To outline the preventive strategies for device-associated infections
3. To be aware of the research gaps in the prevention of device-associated infections
Disclosures

• Clinical reviewer and co-investigator: CADTH (C. difficile and MRSA projects)
• Grants/Contracts: AI-HS, EuroAspire Program, NCCID, PHAC, Sanofi
• Speaker or Participant (last 3 years): Pfizer, BioMerieux, Merck
• Consultant: WHO (AGISAR, GIPC Network)
Case presentation

- An 84 year old female admitted from Pacemaker Clinic to FMC Aug 2012 with pain and swelling over the pacemaker site
  - Background of osteoporosis, atrial fibrillation and anticoagulation, hypertension with LVH and LV diastolic dysfunction, moderate AI, moderate pulmonary hypertension, mild CAD
  - Pacemaker inserted for AF with slow ventricular response and syncope FMC June 2011; minor complication of proximal perforation of cephalic vein otherwise unremarkable
  - Meds: ASA, Bisoprolol, Enalapril, Furosemide, Levothyroxine, Nortriptyline, Warfarin, Nitropatch
Case presentation

- Previous admission RGH ICU Apr 2012 for fever, rigors and hypotension and found to have MSSA bacteremia; all investigations negative for source including TTE; treated parenteral cloxacillin

- Readmitted RGH MTU late May 2012 with lassitude and malaise; blood cultures + MSSA; full workup for source including TEE, nuclear medicine scans all negative

- Referred to HPTP for 6 weeks cloxacillin
Case presentation

- Physical findings of dusky erythema, warmth, and bogginess over the pacemaker site
- Infectious diseases consulted and recommended aspiration
- US revealed complex fluid mass
- Small amount fluid obtained – many PMNs and scant g + cocci with growth *S. aureus*
- OR Aug 17 and pacemaker capsule, pacemaker and lead tip all + MSSA
- New VVI pacemaker on August 24 and cloxacillin for 6 weeks; remained well 1 year
Types of Device-Related Infections

- Intravenous catheter associated (peripheral, midline, central, umbilical, tunneled and non tunneled, ports)
- Implantable cardiac devices (pacemakers, defibrillators, assist devices)
- Urinary tract catheters (upper and lower)
- Chest devices (ETTs, chest tubes, pleurocaths)
- GI tract (stents) and CNS devices (shunts and deep brain stimulators)
- Orthopedic implants
Guidelines

• CDC/HICPAC
• Compendium of Strategies to Prevent HAI(SHEA/IDSA/APIC/SIS/SHM/others)
• PHAC
• IHI 5 Million Lives from Harm
• Others
  ➢ AHA: CV Implantable Electronic Device Infections
  ➢ Hydrocephalus Clinical Research Network
  ➢ Surgical Infection Prevention Project

http://www.shea-online.org/PriorityTopics/CompendiumofStrategiesetoPreventHAIss.aspx
http://www.ihi.org/engage/initiatives/Pages/default.aspx
http://phac-aspc.gc.ca/dpg-eng.php#infection
http://www.cdc.gov/hicpacs/pubs.html
Pathogenesis of SSI

- Inoculum of bacteria $\times$ Virulence = SSI Risk
  Resistance of the host

- Primary source of SSI pathogens: endogenous flora (skin, mucous membranes, hollow viscera)

- Exogenous sources of SSI pathogens
  - Operating room environment
  - Surgical personnel (mainly surgical team)
  - Tools, instruments, materials

Adapted from CDC
Cross Section of Abdominal Wall Depicting CDC Classification of SSI
Pathogenesis of CRI

Microbes migrate intraluminally from colonized hubs, less often from contaminated infusate.
Pathogenesis of CRI

- Microbes may migrate extraluminally from colonized skin
- Microbes adhere to fibrin sheath/thrombus and develop mature biofilm
- Microbes may hematogenously
Pathophysiology of Device-Related Infection (SSI or CRI)

• Microbe related factors

• Host related factors

• Operative/insertion risk factors (includes device related)
Microbe Related Factors

- Inherent virulence
- Adherence properties
- Production of biofilms
- Innate immunity defences

Host Risk Factors

- Extremes of ages (age < 1 year or > 60 years)
- Poor nutritional status/obesity
- Co-morbidities and severity underlying illness
- Systemic steroids/chemotherapy/radiotherapy
- Coincident remote site infection
- Length of stay
- Perioperative transfusion of blood products
- Loss skin integrity (more for line-related)
Operative/Insertion Risk Factors

- Duration of scrub
- Pre-op shaving and skin antisepsis
- Duration of surgery/procedure
- Prophylaxis and its timing
- OR ventilation
- Sterilization of instruments
- Foreign material in site/presence drains
- Surgical technique
Device-Related Risk Factors

- Type of device material
- Frequency of surface irregularities
- Thrombogenecity of device materials
- Use of antibiotic or antiseptic impregnated devices
- Duration of use (longer duration > risk)
- Type and site of placement (cutdown > percutaneous; emergent > elective)
Preventing Device-Related SSIs

1. Preoperative
2. Perioperative
3. Postoperative
Preoperative

- Administer antimicrobial prophylaxis according to evidence-based standards and guidelines (I)
  - Begin administration within 1 hour before incision
  - Select agents based on the procedure and the most common pathogens
  - Discontinue agent within 24 hours
- Do not remove hair at the operative site unless necessary and no razor use (II)
- Use alcohol-containing preoperative skin prep if no contraindication exists (I)
  - Alcoholic chlorhexidine may be preferred

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Principles of Antimicrobial Prophylaxis

- The operation should carry a significant risk of SSI and/or cause significant bacterial contamination or an SSI would be catastrophic.

- Use an agent that is safe, inexpensive, and bactericidal for likely pathogens.

- The shortest course of the most effective and least toxic antibiotic should be used.

- The antibiotic chosen must achieve concentrations > than the MIC of the suspected pathogens in the wound site and be present at the time of incision.
Prophylaxis: Agents, Timing

- 1\textsuperscript{st} and 2\textsuperscript{nd} generation cephalosporins most commonly used agents

- Avoid broad spectrum agents

- General consensus: Administer within 60 min before incision
  - Previously except C-section, after cord clamping but now before clamping (2010)
  - Except vancomycin, infusion time may take longer

Preoperative

- Educate surgeons and perioperative personnel about SSI prevention (III)
  - Education on sterile technique and surgical scrubbing especially housestaff
- Educate patients and their families about SSI prevention (III)
- Implement policies/practices that align with evidence-based standards (II)

Preoperative

- Implement policies/practices that align with evidence-based standards (II)
  - Optimal preparation and disinfection of the operative site and the hands of the surgical team members
  - Adherence to hand hygiene prior to application of skin prep in the OR
  - Reduce unnecessary traffic in the OR
  - Appropriate care and maintenance of operating rooms, including appropriate air handling and optimal cleaning and disinfection of equipment and the environment

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Perioperative

- Maintain normothermia (temperature of 35.5°C or more) during the perioperative period (I)
  - Mild hypothermia risk for SSI
  - Also reduces intraop blood loss
- Optimize tissue oxygenation by administering supplemental oxygen (I)

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Perioperative

- Use impervious plastic wound protectors for gastrointestinal and biliary tract surgery (I)
- Use a checklist (eg WHO) to ensure compliance with best practices (I)
- Implement policies/practices that align with evidence-based standards (II)
  - Reduce unnecessary traffic in the OR (maintain theatre discipline)
  - Appropriate care and maintenance of operating rooms

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What is theatre discipline?

- Poor theatre discipline\textsuperscript{1,2}
  - Jewelry wearing and artificial nails
  - Open isolation gowns in theatre
  - No masks in theatre
  - Personal cameras in OR adjacent to incisions
  - Improper handling of medical devices
  - Too many personnel in the theatre
  - Frequent and unnecessary entry/exit from OR

\textsuperscript{1}Recommended practices for preoperative patient skin antisepsis. In: Perioperative Standards and Recommended Practices. Denver, CO: AORN, Inc; 2013:75-90

Dress code policy
Postoperative Factors

- Control blood glucose during the immediate postoperative period (I/II)
- Perform surveillance for SSI (I)
- Increase the efficiency of surveillance using automated data (II)
- Provide feedback of SSI rates (II)
- Provide feedback on rates of compliance with process measures (III)
Unresolved Issues and Research Gaps

- No standard protocol for preoperative showers/baths with an antiseptic agent the night before surgery
- Admission screening *S. aureus*
- RCTs vs quasi-experimental and cohort studies on issues of theatre discipline - major ethical issues
- Optimal device materials to prevent infection


2Webster J, Osborne S. Preoperative bathing or showering with skin antiseptics to prevent surgical site infection Cochrane Database Syst Rev. 2012 Sep 12;9:CD004985. d10.1002/14651858.CD004985.pub4
Preventing Central Line - Related Infections

1. Pre-insertion
2. Peri-insertion
3. Post-insertion
Pre-Insertion

- Minimize unnecessary CVC (III)
- Require education of HCEs involved in insertion, care, and maintenance of CVCs (II)
  - Complete educational program and renew at intervals
  - Credentialing
  - Use of simulation
- Bathe ICU patients over 2 months of age with a chlorhexidine preparation daily (I)
  - Role in non ICU patients unknown
  - Unresolved issue in pediatric patients < 2 months

Peri-Insertion

- Process in place to ensure adherence to infection prevention practices at the time of CVC insertion (II)
  - Document adherence to aseptic technique (checklist or direct observation)
- Hand hygiene prior to insertion (II)
- Avoid femoral site (I)
- Use of pre-loaded cart for supplies (II)
- Use US guidance for IJ (II)
- Maximal barrier precautions (II)
- Alcoholic chlorhexidine antiseptic for skin preparation (I)

Post-Insertion

- Ensure appropriate nurse-to-patient ratio and limit the use of float nurses in ICUs (I)
- Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter (II)
  - Use CHG or alcohol or PI
  - Friction for no < 5 sec
  - Monitor compliance
- Remove nonessential catheters (II)
- For non-T CVCs △transparent dressings and perform site care with a GHG antiseptic q5-7d; gauze q2d; immediately if soiled, loose, or wet (II)

Post-Insertion

- Replace administration sets not used for blood, blood products, or lipids at intervals no > 96h (I)
- Use antimicrobial ointments for hemodialysis catheter-insertion sites (I)
  - PT triple or PI preferred
  - Do not use mupirocin ungt
- Perform surveillance for CLABSI in ICU and non-ICU settings (I)
  - Measure the unit-specific incidence of CLABSI (CLABSI per 1,000 catheter-days) and report regularly
  - Benchmark internally and externally

Unresolved Issues and Research Gaps

- Recognition of limitations of the data
- Use of antiseptic and antimicrobial impregnated catheters/hubs and risk of resistance
- Use of antiseptic impregnated dressings if CHG washes used
- Extent of use of antibiotic locks for CVCs
- Routine use needleless connectors to reduce infection risk
- Use of teams for CVL insertion
- Transparent vs dry gauze dressings
- Rise of chlorhexidene and silver resistance