Management and Prevention of Cardiovascular Implantable Electronic Device Infections

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Outline

• Cardiac Implantable Electronic Devices (CIED) include:
  Permanent pacemakers (PPM) and Implantable cardioverter defibrillators (ICDs)
  – Epidemiology with a case
  – Manifestations of pocket infections, bloodstream infections and device related endocarditis
  – Diagnosis
  – Treatment
• Prevention of Cardiac Device Infections (CDI)
Background: Scope of Use

- PPM: 1960s
- ICDs: 1980s
  - 70% of device recipients are >65
  - 20-35% were more than 80 in 2001
  - Dual chamber pacing used more than single
- Nat Hospital Discharge Survey:
  - 49% increase in new implants (99-03)
  - In 2003, 180K PPM and 57K ICDs in place
  - More of current increase with ICDs (160%) vs PPM 31%

Voight, JACC 2006; 48:3: 1851-9; Sohail, 2007 JACC 49;18, 1851;

80 yr old white female

- A fib w/ rapid ventricular response for years
- PPM placed in 2007, rate controlled
- PMHx: Prosthetic right hip, cardiomyopathy EF 15%
- Sick for 6 months w/ fever; tx with multiple courses of oral antibiotics, fatigue, 15# wt loss
- Multiple visits to cardiologist and family medicine
- 7-2-2010 to OSH ED: first blood cx +; oral levofloxacin
- 7-28-2010 to OSH PE: VS with 103F, otherwise WNL; HEENT: upper dentures, lowers fine, Lungs: rales at bases, CV: RRR, Abd / Ext: neg….Admitted: blood cx + S. epi 4/4
- TT Echo mobile density attached to pacing wire, thick TCV
- D/C on vancomycin and rifampin 7-30-2010 as the "conservative approach; Staph epi is probably a contaminant"
Risk Factors for Device Infection

- Patient Factors (Odds Ratios where listed)
  - Immunosuppression
    - renal dysfunction 4.8
    - corticosteroid use 13.9
  - Oral anticoagulant use
  - Coexisting illnesses such as diabetes mellitus
  - Amount of indwelling hardware

- Procedural characteristics
  - Not administering antimicrobial prophylaxis
  - Device revision/replacement (2% vs <1% risk)
  - Physician experience / surgical technique
    - lowest quartile of implantation volume 2.47
  - Microbiology if bloodstream infection i.e. Staph aureus

Cardiac Device Infections (CDI)

<table>
<thead>
<tr>
<th>Intra-cardiac Device:</th>
<th>Infection Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent pacemaker (PPM)</td>
<td>0.13-19.9</td>
</tr>
<tr>
<td>Implantable cardioverter defibrillator (ICD)</td>
<td>0 - 3.2</td>
</tr>
<tr>
<td>Ventricular assist device</td>
<td>13- 80.0</td>
</tr>
</tbody>
</table>

Voight, JACC 2006; 48:3: 1851-9; Sohail, 2007 JACC 49;18, 1851; Gandleman Cardiology in Review 2007:15;1 13; Baddour, L. Circulation 2010 121: 258.
### Clinical Manifestations

- **Pocket infection:**
  - Localized changes at site with swelling, erythema, pain, warmth, fluctuance, drainage, erosion, dehiscence of overlying skin
  - Blood cx are positive ~50%
- **PPM or ICD related Endocarditis:**
  - Oscillating intra-cardiac mass on the electrode leads, valves or endocardial surface + lead or tip cx by echo
- **Occult bacteremia /fungemia** with no local signs at pocket site

### Predictors of In hospital Mortality with Cardiac Devices

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR</th>
<th>Lower</th>
<th>Upper</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age per 20-yr increase</td>
<td>1.63</td>
<td>1.41</td>
<td>1.89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female gender</td>
<td>0.86</td>
<td>0.72</td>
<td>1.03</td>
<td>0.11</td>
</tr>
<tr>
<td>Race minorities vs. Caucasians</td>
<td>1.12</td>
<td>0.85</td>
<td>1.48</td>
<td>0.42</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.03</td>
<td>0.81</td>
<td>1.31</td>
<td>0.82</td>
</tr>
<tr>
<td>Renal failure</td>
<td>1.76</td>
<td>1.26</td>
<td>2.47</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Type of device implanted (ICD vs. PM)</td>
<td>0.78</td>
<td>0.55</td>
<td>1.11</td>
<td>0.17</td>
</tr>
<tr>
<td>Hospital size (per 100-bed increase in size)</td>
<td>1.04</td>
<td>0.97</td>
<td>1.12</td>
<td>0.26</td>
</tr>
<tr>
<td>CRMD Infection</td>
<td>2.41</td>
<td>1.58</td>
<td>3.66</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Voight, JACC 2006; 48:3: 1851-9;
Cardiac Device Infection: Defined/ Confirmed

• Positive cultures from:
  — Generator pocket
  — Lead or
  — Blood (with local signs at generator pocket)
  OR
  - Absence of another source of bacteremia and resolution of BSI after device explantation

• Relapse:
  — Recurrence of the device infection w/ same microbe

80 yr old white female

• Pos blood cx Staph capitus 8-10 and neg 8-15
• 8-15 Trans-esophageal echo with right atrial pacer wires and TCV involvement
• Transferred to OSU 8-16 after echo
• 8-16 Echo here with multiple large masses
  — 30x 11 and 22x14 on the ICD lead one each on the atrial and on TCV prolapsing into the RV
  — 15x15 on the intraventricular septum on the left
  — OR: unable to remove LVOT vegetation due to friable tissues; TCV was OK, severe LV dysfunction
• PPM endocarditis: tissue/ leads grew MRSE, Candida
**Table 2**  Clinical Presentation of Patients With CDI (n = 189)

<table>
<thead>
<tr>
<th>Presenting Signs/Symptoms</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic symptoms</td>
<td></td>
</tr>
<tr>
<td>Fever (&gt;38°C)</td>
<td>82 (43)</td>
</tr>
<tr>
<td>Chills</td>
<td>73 (39)</td>
</tr>
<tr>
<td>Malaise</td>
<td>79 (42)</td>
</tr>
<tr>
<td>Anorexia</td>
<td>32 (17)</td>
</tr>
<tr>
<td>Nausea</td>
<td>36 (20)</td>
</tr>
<tr>
<td>Sweating</td>
<td>34 (18)</td>
</tr>
<tr>
<td>Hypotension (systolic blood pressure &lt;90 mm Hg)</td>
<td>18 (10)</td>
</tr>
<tr>
<td>Murmur on auscultation</td>
<td>66 (35)</td>
</tr>
<tr>
<td>Symptomatic heart failure</td>
<td>52 (28)</td>
</tr>
<tr>
<td>Local findings at generator site</td>
<td></td>
</tr>
<tr>
<td>Erythema</td>
<td>128 (68)</td>
</tr>
<tr>
<td>Pain</td>
<td>93 (49)</td>
</tr>
<tr>
<td>Swelling</td>
<td>127 (67)</td>
</tr>
<tr>
<td>Warmth</td>
<td>71 (38)</td>
</tr>
<tr>
<td>Tenderness</td>
<td>89 (48)</td>
</tr>
<tr>
<td>Drainage</td>
<td>66 (36)</td>
</tr>
<tr>
<td>Purulent discharge</td>
<td>66 (36)</td>
</tr>
<tr>
<td>Skin ulceration</td>
<td>59 (31)</td>
</tr>
<tr>
<td>Generator/lead erosion</td>
<td>48 (26)</td>
</tr>
<tr>
<td>Intraoperative presence at generator pocket</td>
<td>513 (93)</td>
</tr>
</tbody>
</table>

**Laboratory abnormalities**

- Leukocytosis (WBC >10 × 10³/l): n = 189 - 82 (43)
- Anemia (HCT <38% in men and <35% in women): n = 188 - 94 (50)
- High erythrocyte sedimentation rate (ESR >22 mm/h in men and >20 mm/h in women): n = 70 - 47 (25)
- Positive blood culture (n = 188): n = 76 - 76 (40)

**Pacer / ICD Infections (138 PPM, 51 ICDs)**

![Chart showing microbiology of PPM/ICD Infections]

**Figure 1**  Microbiology of PPM/ICD Infections (n = 189)

ICD = Implantable cardioverter-defibrillator; PPM = permanent pacemaker.
Microbiology

- In patients with *S. aureus* bacteremia, (SAB) concomitant device infection is present in 50% or more.
  - TEE with sensitivity of >95%
  - Ultrasound of generator pocket, WBC scan
  - Consider removal when, no focus for SAB

Baddour et al. *Circulation* 2010; 121: 458
Making the Diagnosis

- Blood cultures must be obtained in all cases, before antibiotics!

- If pocket site is draining, swab site
  - Gram stain and culture, anaerobic cultures

- If there are positive blood cultures or negative blood cx (because antibiotics were given) obtain TEE

Management of PPM and ICD

- Remove PPM or ICD, completely
- Device related endocarditis in 33-66%, if not removed and <18% if completely removed.
- Two step exchange is recommended
  - Complete removal and repeat blood cx
  - Replace in
    • 72 hrs if lead vegetation, neg. blood cx
    • After 2 weeks if valve vegetations
- Adequate control of infection of generator pocket and clearance of BSI
80 year old female

- Repeat blood cultures negative
- PICC placed
- Vancomycin 1.5 grams per day
- Rifampin 300mg BID
- Fluconazole 400 per day
- Wearing a vest
- Treated for 4 weeks
- Ready to re-implant?

Baddour et al. Circulation 2010; 121: 458
Rising Rates of Device Infections

Figure 1. Proportional increase in cardiac devices implanted and those infected by year of hospitalization, normalized to the number of devices implanted and infected in 1996, respectively. Note the dramatic increase in device infections compared with device implantations, after 2000.

Pacemaker/AICD SSI

Infection Rate (IR) per 100 procedures

NHSN Benchmark Risk 0,1,2, 3 = 0.22

<table>
<thead>
<tr>
<th>Infections</th>
<th>Q3 07</th>
<th>Q4 07</th>
<th>Q1 08</th>
<th>Q2 08</th>
<th>Q3 08</th>
<th>Q4 08</th>
<th>Q1 09</th>
<th>Q2 09</th>
<th>Q3 09</th>
<th>Q4 09</th>
<th>Q1 10</th>
<th>Q2 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedures</td>
<td>384</td>
<td>341</td>
<td>296</td>
<td>390</td>
<td>345</td>
<td>391</td>
<td>341</td>
<td>390</td>
<td>401</td>
<td>319</td>
<td>358</td>
<td>347</td>
</tr>
</tbody>
</table>

Pacemaker/AICD SSI

Infection Rate (IR) per 100 procedures

NHSN Benchmark Risk 0,1,2, 3 = 0.22

<table>
<thead>
<tr>
<th>Q2 08</th>
<th>Q3 08</th>
<th>Q4 08</th>
<th>Q1 09</th>
<th>Q2 09</th>
<th>Q3 09</th>
<th>Q4 09</th>
<th>Q1 10</th>
<th>Q2 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>369</td>
<td>345</td>
<td>391</td>
<td>341</td>
<td>390</td>
<td>401</td>
<td>319</td>
<td>358</td>
<td>347</td>
</tr>
</tbody>
</table>
## Pacer/AICD Line List Q2 10

<table>
<thead>
<tr>
<th>Procedure Date</th>
<th>Procedure</th>
<th>Date of onset of Infection</th>
<th>Pathogen</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-10</td>
<td>Medtronic D224 TRK Consulta; Device removal; new device implanted</td>
<td>5-7-10: pacer; pocket; blood</td>
<td>MRSA</td>
<td>? Pre-op Abs; CHG bathing?: 5-7-10; device, 2 ICD leads, 1 atrial lead removed; temporary pacer; debridement of pocket; TEE mobile echodense lesions suspicious for vegetations MSOF; New device implanted 6-1-2010:</td>
</tr>
<tr>
<td>6-10</td>
<td>St. Jude Pacesetter CD2231-40 Fortify; Implant vent &amp; atrial lead, implant defibrillator, testing</td>
<td>7-11-10: blood; pocket</td>
<td>MSSA</td>
<td>Vanc 1.5 Gm on call to EP; CHG bathing? 7-12-10: TEE no evidence endocarditis, Defibrillator removed, extraction of 1 ICD, 1 atrial lead; 7-17-10 temp pacer; new device implanted 7-20-10</td>
</tr>
<tr>
<td>6-10</td>
<td>Medtronic D224 DRG Secura: Removal implanted defibrillator, extraction 1 ICD lead, Implant transvenous defibrillator electrode; Re-implant of same device (spurious shocks; fx lead)</td>
<td>7-12-10 abd pocket</td>
<td>MRSE</td>
<td>Vanc 1.5 Gm; CHG bathing X 2, + SAGE 7-12-10: Developed large hematoma; wound opened up. TEE shows no vegetations, no endocarditis; Device removed 1 atrial lead, 1 ventricular lead and extraction of subcutaneous lead</td>
</tr>
</tbody>
</table>

## Interventions to Decrease CD Infections

- Maximal sterile barriers during all EP procedures
- Attention to environmental surfaces in EP suites; routine checking to assess cleanliness of procedure rooms
- Waterless sanitizer AVAGARD education – EP docs
- Maintaining the sterile field EP staff
- Post op dressing not to be removed until POD 2
- Vancomycin: pre-op prophylactic due to MRSA rates
- ID consult; clear infection prior to reinsertion
- Post op instructions; showering, dressing removal etc.
- Nasal screening???
Findings on Environmental Rounds

- Dust in procedure rooms – Housekeeping notified;
  - staff to check rooms prior to first procedure of the day
- Excess supplies stored in the suites on top of cabinets collecting dust; impedes housekeeping;
  - staff to stock extra supplies in cabinets in control room, control par levels
- Facilities to assess air intake vents and exhaust vents
- Sterile supplies: introducers outside of box in plastic individual wrapping; contain in boxes, none on floor
- Mask use mandatory during procedure
- Bottles of betadine at scrub sink; need to use the Avagard and CHG

OSUMC CARDIOTHORACIC AND VASCULAR PREOPERATIVE ANTIBIOTIC ORDERS 12-1-09

The optimal time to start all antibiotics listed is 15-60 minutes prior to incision. If case is delayed, the physician may re-dose agent 1 time prior to incision; EXCEPT gentamicin or vancomycin. Prophylactic antibiotics need to be given regardless of other antibiotics prescribed for the patient; consideration should be given prior to dose/time especially if patient is receiving vancomycin, amikacin, gentamicin, or tobramycin.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Agent</th>
<th>Infusion Time</th>
<th>Dose</th>
<th>Re-dose if still in OR or if EBL is greater than 1/2 blood volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacemaker s/AICDs with or without PCN allergy</td>
<td>Vancomycin</td>
<td>60-120 min</td>
<td>1.5 gm</td>
<td>IVPB</td>
</tr>
</tbody>
</table>

* Ideal Body Weight (IBW) in kg: Males = 2.3(# of inches over 5ft) + 50; Females = 2.3(# of inches over 5ft) + 45
† For Mechanical Circulatory Support (VAD, ECMO): If hospitalized more than 5-7 days, Fluconazone 400 mg PO/IV may be added to Vancomycin and Amikacin. If using Vancomycin, allow at least a 2 hour infusion time with 1.5 gram dose.
**VAD INFECTIONS**

- Infections are a major complication of VAD
- Rates vary depending on definitions utilized (25-70%)
- Infections identified are often driveline related, but other HAI also play a role
- Risk factors for death: XS VAD duration, MOSF, prolonged ICU stay
- Sepsis with shock and organ dysfunction can be caused *S. aureus* and *P. aeruginosa*.
- Subacute presentations with less virulent pathogens
- Recovery of skin flora at driveline exit sites or open wounds is more difficult to define as pathogen vs. contaminant; Gram stain is helpful

## Studies of VAD Infections

<table>
<thead>
<tr>
<th>Study</th>
<th>LVAD Patients</th>
<th>SSI Rate 1000 VAD Days</th>
<th>SSI Rate 100 LVAD Insertions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisher (CID 1997)</td>
<td>20</td>
<td>8.4</td>
<td>44.4</td>
</tr>
<tr>
<td>Malani (CID 2002)</td>
<td>36</td>
<td>14</td>
<td>44.4</td>
</tr>
<tr>
<td>Gordon (Ann Th Surg 2001)</td>
<td>236</td>
<td>8</td>
<td>4.9</td>
</tr>
<tr>
<td>Simon (CID 2005)*</td>
<td>77</td>
<td>4.9</td>
<td>3.1</td>
</tr>
</tbody>
</table>

## Destination Therapy

- **REMATCH Trial**

  - 129 patients with end-stage CHF who were not transplant candidates were randomly assigned to receive VAD versus optimal medical management.

  - Kaplan-Meier survival analysis showed a reduction by 48% in the risk of death from any cause in the VAD group.

  - *Rose et al, N Engl J Med 2001*
Conditions Making a CLA-BSI Complicated

Metastatic Sites of Infection from CLA-BSI
- Osteomyelitis
- Endophthalmitis
- Septic Arthritis
- Epidural abscess
- Endocarditis
- Suppurative thrombophlebitis
- Other implanted devices
- WILL ALWAYS TREAT LONGER ≥ 4 wks

VAD Infection Definitions

- Driveline infection:
  - Present with local inflammatory changes and drainage at the cutaneous exit site
- VAD pocket site
  - Local inflammatory changes
- Endocarditis
  - Less frequently seen with infection involving valves and/or the internal (blood-contacting) lining of the device

Changing Characteristics of Infections
In Patients Requiring
Long-Term Ventricular Assist Devices (VAD)

• VADs are used to treat end stage heart disease as a bridge to recovery, bridge to transplant or as destination therapy.

• VAD infection rates reflect infections of the VAD driveline, pocket, surgical site or primary VAD associated blood stream infection (VAD-BSI), i.e. related to no other identified source or CVC.

• Objective: Determine if rigorous multi-disciplinary pre, intra, and post-operative and post discharge process improvements can reduce VAD infection rate.

Wellington, Blais, Firstenberg, Sun, Mangino SHEA 2009

Methods I

• IRB approval was obtained
• Retrospective review of all VAD recipients included:
  – insertion and removal dates,
  – device type, radiology, micro reports,
  – antibiotic prophylaxis and clinical notes.
• Pts divided into 2 groups (P1 and P2) for comparison.
• Assignment to group was based on device insertion date, with P2 reflecting patients having devices inserted following process improvements.
  – (P1): n=50, 1/1/2000 to 7/31/2005
  – (P2): n=96, 8/1/2006 to 7/31/2008
• VADS placed between 8/1/05 to 7/31/06 are not included due to a gap in personnel to perform surveillance.
Methods II

Process improvements implemented in P2 based on the (REMATCH), ACC/AHA practice guidelines and the CDC Guideline for Prevention of Surgical Site Infections.

• Standardized pre-op prophylactic administration of vancomycin, aztreonam and fluconazole (if hospitalized >5 days) with timing, dose and re-dose specified
• Pre-op bathing X 2 with 4% chlorhexidine gluconate (CHG)
• Pre-op wash w/ 2% CHG disposable cloth in pre-op holding
• Tinted pre-op skin prep with ChloroPrep®
• Insulin drip to maintain BS level ≤ 150 intra-operatively
• Control operating room traffic, esp. near pump assembly table
• Post op incision care, sterile technique for dressing changes
• Encourage use of an abdominal binder to secure the driveline
• Development of patient and staff education materials
• *Staphylococcus aureus* nasal screening (began 1/08, compliant 12/08)
• Data was entered into a Microsoft Excel 2003 database.

<table>
<thead>
<tr>
<th>Infection / Organism</th>
<th>Period I</th>
<th>Period 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No organism identified</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><em>Candida sp</em></td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><em>Aspergillus sp</em></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>MSSA</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>MRSA</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>MRSE</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><em>Coag neg staph</em></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><em>E. faecalis</em></td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>(VR) <em>E. faecium</em></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><em>Burkholderia cepacia</em></td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><em>Serratia marcescens</em></td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

N=22
No organism = 13.6%
Fungi = 22.7%
Gram pos = 40.9%
Gram neg = 22.7%

N=21
No organism = 9%
Fungi = 9.5%
Gram pos = 52.3%
Gram neg = 38.0%
<table>
<thead>
<tr>
<th></th>
<th>Period 1 01/01/00 – 07/31/05</th>
<th>Period 2 08/01/06 – 07/31/08</th>
</tr>
</thead>
<tbody>
<tr>
<td># of VADs implanted</td>
<td>50</td>
<td>96</td>
</tr>
<tr>
<td># of patients with devices implanted</td>
<td>43</td>
<td>82</td>
</tr>
<tr>
<td>Male</td>
<td>72%</td>
<td>75%</td>
</tr>
<tr>
<td>Female</td>
<td>28%</td>
<td>25%</td>
</tr>
<tr>
<td>Mean age</td>
<td>53.8 yrs</td>
<td>51.4 yrs</td>
</tr>
<tr>
<td># of infections*</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>Total device days</td>
<td>4390</td>
<td>17,535</td>
</tr>
<tr>
<td>Infection rate per 1000 device days</td>
<td>5.01</td>
<td>1.20</td>
</tr>
</tbody>
</table>

**Results**

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection rate/1000 device days (d)</td>
<td>5.01</td>
<td>1.2</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Median Onset of VAD infection</td>
<td>25 d</td>
<td>89 d</td>
<td>&lt;0.002</td>
</tr>
</tbody>
</table>
Results

• Audits of processes were performed to ensure standardization of all patient care practices. Data was shared with process owners at least quarterly.

• Concomitant improvements in technology occurring during the two study periods may have contributed to reductions in infection rates, delays in onset of infection and increases in device days.

• Comparison of P1 and P2 infection rate by device type was complicated by design modifications and indications / respective advantages of available devices.

• In P2, there was no significant association of infection rate by device type (Abiomed, Levitronix, Thoratec, Heartmate II, Heartmate XVE and Ventrassist).

Results

• Gram positive organisms accounted for the greatest number of infections.

• Further opportunities to prevent *Staphylococcus aureus* infections may be possible.
  – Compliance with *S. aureus* nasal screening and mupirocin administration, if positive was not achieved in P2.

• Adequate securing of the VAD driveline with a binder, may further reduce infection risk; when minor trauma to the driveline site was documented, it appeared to lead to an infection.
Success

• The infection rate for VAD recipients had a significant decrease to 1.20 per 1000 device days.

• The median onset to infection increased from 25 days (mean 36.3) to 89 days (mean 107.3 days) in P2; with fewer fungi and more P. aeruginosa.

• Reduction and delay of onset of VAD infections are a result of a multidisciplinary approach to standardize all pre-operative, intra-operative, post-operative and post discharge infection prevention processes.

Hand Hygiene and Aseptic Technique

• Use waterless alcohol-hand rub or an antibacterial soap and water

• Maximal barrier precautions are necessary for the operator at time of insertion.

  Includes:
  • Sterile gown
  • Sterile gloves
  • Sterile drape
  • Mask
  • Cap

## Prospective Randomized Study
### Maximal Barrier Precautions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimal Precautions</th>
<th>Maximal Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterile gloves</td>
<td>Sterile gloves</td>
<td>Sterile gloves</td>
</tr>
<tr>
<td>Small drape</td>
<td>Large drape</td>
<td>Sterile gown</td>
</tr>
<tr>
<td>Mask</td>
<td></td>
<td>Mask</td>
</tr>
<tr>
<td>Cap</td>
<td></td>
<td>Cap</td>
</tr>
<tr>
<td>No. of catheters</td>
<td>167</td>
<td>176</td>
</tr>
</tbody>
</table>
| No. of CR-BSI CR-BSI / 1000 d | 6 (3.5%) | 1 (0.6%)

|                      | 0.5                  | 0.08 (p<0.02)       |

Raad ICHE 1994:231-238.

## Antimicrobial Property

<table>
<thead>
<tr>
<th>Antimicrobial Property</th>
<th>PVP-I &amp; Alcohol</th>
<th>Tincture of Iodine</th>
<th>CHG &amp; Alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad spectrum</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Rapid activity</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Persistent activity</td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Maintain its activity</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Non-irritating non-toxic</td>
<td></td>
<td>√(+/-)</td>
<td></td>
</tr>
<tr>
<td>Minimal absorption</td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
The Importance of Friction Scrub

A risk factor for CR-BSI:

Heavy skin colonization at insertion site, especially prior to insertion.

Eighty % of resident and transient skin flora resides in the first 5 epidermal layers.

INFECTION PREVENTION

IS IN YOUR HANDS