Infectious Complications in Vascular Patients

Shireesha Dhanireddy, MD
Medical Director, Infectious Disease Clinic
Harborview Medical Center
Associate Professor, Department of Medicine
University of Washington

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DISCLOSURES

Shireesha Dhanireddy, MD

- No relevant financial relationship reported
Objectives

• Overview of types of infections seen in vascular patients
• Epidemiology/Risk Factors
• General management strategies
• Prevention
Types of Infections

- Surgical wound infections
- Vascular graft infections
The Numbers

• SSI in vascular surgery: 4% to 25% - 43% depending on type of study
• Prosthetic graft infection: 0.5% - 6% depending on location
  – <1% for sub renal aortic bypass
  – 0.4% - 3% for open aortic aneurysm repair
  – 1-2% for aortofemoral bypass
  – up to 6% for infra-inguinal bypass
  – 3-8% for arteriovenous dialysis access grafts
  – Endovascular repair risk unclear, but appears to be very low (<1%)
• Death rate for VPGI: 15-75% (amputation rate ~70%)

Fitzgerald, J Antimicrob Therapy, 2005
Legout, Med et Mal Infectieuses, 2012
Surgical Wound Infections

• ‘07–’08 prospective multi-center Finnish study. Infrarenal aortic or lower limb arterial surgery. Standard pre-op prophy, in OR shaving. 1 m f/u.
  – 64 (35%) included prosthetics or patches
  – 49/184 (27%) with SSI (standard CDC definition)
  – 2 went on to amputation
  – 71% *S aureus*, then coag-negative staph, *E coli*
  – Risk factors for SSI: infrainguinal surgery, obesity, arteriography injection within the injection site.
  – Attributable cost: €3320 ($4359)

Turtiainen, Scand J Surg, 2010
Risk factors for surgical wound infection

- Increased age
- Obesity
- DM
- Infra-inguinal surgery
- Redo surgery
- ? arteriography within operative site
found in 32% of wounds. Patients presenting with early (<4 months) VSSI were most likely to have MRSA, whereas late-presenting patients (>4 months) were most likely to have *S. epidermidis*. Gram-negative organisms were found most often in early-presenting infections, with the exception of *Pseudomonas* species, which were cultured equally between the early and late groups. A substantial number of patients

<table>
<thead>
<tr>
<th>Pathogens by Infection Presentation Timing</th>
<th>Total (n = 87)</th>
<th>Early VSSI (n = 50)</th>
<th>Late VSSI (n = 37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Gram positive</td>
<td>52 (60%)</td>
<td>27 (54%)</td>
<td>25 (68%)</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>10</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>MRSA</td>
<td>22</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td><em>Staphylococcus epidermidis</em></td>
<td>17</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>VRE</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><em>Streptococcus</em></td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pure Gram negative</td>
<td>8 (9%)</td>
<td>6 (12%)</td>
<td>2 (5%)</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><em>Serratia</em></td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><em>Alcaligenes X</em></td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><em>Candida</em></td>
<td>1 (1%)</td>
<td>1 (2%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Mixed</td>
<td>20 (23%)</td>
<td>13 (26%)</td>
<td>7 (19%)</td>
</tr>
<tr>
<td>Unknown/No growth</td>
<td>6 (7%)</td>
<td>3 (6%)</td>
<td>3 (8%)</td>
</tr>
</tbody>
</table>

NOTES: VSSI = vascular surgical site infection; MRSA = methicillin-resistant *Staphylococcus aureus*; VRE = vancomycin-resistant enterococci.
Vascular Graft Infection: A Model of Pathogenesis

Vascular surgery

DM
Vascular disease
Trauma
Tobacco use

Tissue injury
Lymphatic disruption
Hematoma formation

Prosthetic graft material

Bacterial biofilm production

1 month
<4 months
>4 months

Bacteria from endogenous or exogenous source

Clinical signs of graft infection and/or failure

MRSA?
Pseudomonas?
S. epidermidis?

Vascular surgery + antibiotics
Prevalence and outcome of prosthetic vascular graft infection: a review of patient characteristics, microbiological data, and treatment variables in a paucity of evidence.

### Table 3

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Survivors (n = 71)</th>
<th>Non-survivors (n = 14)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>66.8 ± 12</td>
<td>73.3 ± 7.9</td>
<td>0.04</td>
</tr>
<tr>
<td>Age ≥70 years</td>
<td>32 (45.1)</td>
<td>12 (85.7)</td>
<td>0.005</td>
</tr>
<tr>
<td>Male gender</td>
<td>61 (85.9)</td>
<td>13 (92.8)</td>
<td>0.47</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>5 (7)</td>
<td>0 (0)</td>
<td>0.3</td>
</tr>
<tr>
<td>Overweight/obesity</td>
<td>42 (59)</td>
<td>8 (57.1)</td>
<td>0.88</td>
</tr>
<tr>
<td>Severe renal insufficiency</td>
<td>5 (7)</td>
<td>2 (14.3)</td>
<td>0.36</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>20 (28)</td>
<td>4 (28.6)</td>
<td>0.97</td>
</tr>
<tr>
<td>Immunosuppression</td>
<td>11 (15.5)</td>
<td>0 (0)</td>
<td>0.11</td>
</tr>
<tr>
<td>Chronic pulmonary disease</td>
<td>12 (16.9)</td>
<td>4 (28.6)</td>
<td>0.3</td>
</tr>
<tr>
<td>Arterial hypertension</td>
<td>56 (78.8)</td>
<td>10 (71.4)</td>
<td>0.54</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>34 (47.9)</td>
<td>10 (71.4)</td>
<td>0.1</td>
</tr>
<tr>
<td>Aortic graft infection</td>
<td>42 (59)</td>
<td>12 (85.7)</td>
<td>0.06</td>
</tr>
<tr>
<td>Early-onset infection</td>
<td>44 (60.8)</td>
<td>5 (10.2)</td>
<td>0.08</td>
</tr>
<tr>
<td>Positive blood samples</td>
<td>23 (32.4)</td>
<td>6 (42.8)</td>
<td>0.45</td>
</tr>
<tr>
<td>Polymicrobial PVGI</td>
<td>14 (19.7)</td>
<td>6 (42.8)</td>
<td>0.06</td>
</tr>
<tr>
<td>PVGI caused by Gram-positive cocci</td>
<td>41 (83.7)</td>
<td>8 (16.3)</td>
<td>0.97</td>
</tr>
<tr>
<td>PVGI caused by Gram-negative bacilli</td>
<td>22 (31.0)</td>
<td>8 (57.1)</td>
<td>0.07</td>
</tr>
<tr>
<td>Surgical debridement with excision of infected graft</td>
<td>33 (46.5)</td>
<td>8 (57.1)</td>
<td>0.47</td>
</tr>
<tr>
<td>Admission to ICU</td>
<td>28 (39.4)</td>
<td>12 (85.7)</td>
<td>0.001</td>
</tr>
<tr>
<td>Septic shock during the surgical procedure</td>
<td>12 (16.9)</td>
<td>5 (35.7)</td>
<td>0.1</td>
</tr>
<tr>
<td>Appropriate initial empirical antibiotic treatment</td>
<td>62 (87.3)</td>
<td>13 (92.5)</td>
<td>0.55</td>
</tr>
<tr>
<td>Use of aminoglycoside in the initial antibiotic treatment</td>
<td>23 (32.4)</td>
<td>5 (35.7)</td>
<td>0.8</td>
</tr>
</tbody>
</table>

ICU, intensive-care unit; PVGI, prosthetic vascular graft infection. Data are expressed as n (%) or mean ± standard deviation.
Imaging

- Contrast-enhanced CT: quick, image guided sampling
  - ~100% sensitive-specific in early infection
  - Decreases to ~55% in late infection
  - Anastomotic air bubbles? Should be gone after 7 weeks
  - Periprosthetic hematoma? <20% by 45 days, <10% by 100 days
Imaging

- MRI: not better than CT for early VPI, but only limited studies
- Nuclear medicine: maybe better than all above?
  - Scinitigraphy (tagged WBCs) appears to be superior for late VPI
  - PET-scanning sens 98.2%, spec 75.6%, PPV 88.5%, NPV 84.4%
  - Lacks anatomic data
  - Hard to access
- Doppler: good for thrombosis, collections
Diagnosis

• Positive intra-operative samples or blood cultures, preferably 2 for commensal bacteria
• Local or general clinical signs of infection: fever, chills, etc
• Lab or imaging: WBC > 10,000, CRP > 10 mg/L, fluid collections, periprosthetic air bubbles >6-8 weeks out, abscess or false aneurysm
• Think VPI when patient presents with a distant site infection in the months following surgery
Antimicrobials I

- Antibiotics should be held until samples are obtained unless patient is severely septic

- No consensus on best drug based on organism(s), timing of presentation, severity of infection, or status of prosthetic material/graft (daptomycin / linezolid / vancomycin?)

- Antibiotic therapy should be narrowed to the most specific, most potent, and least toxic drug possible as soon as culture results are available

- Treatment choices are based on experience, studies and extrapolations from other processes, such as orthopedic prosthetic joint infections and endocarditis
Antimicrobials II

Duration

– Arterial allograft/homograft or prostheses: 6 weeks IV + 6 months PO (at least). 6 week mark based on endothelialization of prosthesis

– Venous graft: 3 weeks

– If infected material remains in place: indefinite suppressive therapy with doxycycline, TMP-SMX, or a fluoroquinolone may be necessary
Surgical Approach

- Conventional / traditional approach
- Conservative / graft preservation approach
- Combined (modern?) approach
Other Therapies

- Antibiotic impregnated PMMA beads - only case series data
- Antibiotic powder - small case series
- Antibiotic-impregnated grafts
  - PTFE
  - Dacron (weaved/knitted, preclot/collagen/gelatin)
    - Rifampin (covers GPCs, no GNRs), lots of animal data, use supported by metaanalysis comparing extraanatomic bypass, cryopreserved allografts, autogenous veins and rif-dacron grafts - the latter appeared to be best option.
    - Effect on MRSA less clear

Lew and Moore, Sem Vasc Surg, 2011
O’Connor, J Vasc Surg, 2006
2010 Cochrane Review*

- 10 antibiotic prophylaxis vs placebo (YES)
- 10 different prophylactic abx or dose (NO)
- 3 short duration abx (<24h) vs longer duration (NO)
- 3 rifampicin impregnated graft material (prophylaxis) (NO)
- 3 preoperative skin antisepsis (NO beyond standard practices)
- 2 each: suction wound drainage, closed *in situ* bypass techniques (NO, NO)
- 1 each: wound closure technique, single dose abx (NO, NO)

*oldest RCT 1981, newest 2000, most in ‘80s and ‘90s*
Prevention

• Pre-operative washing with chlorhexidine soap
  – Decreases wound infection rates from 17.5 to 8%

• MRSA swab of nares and open wounds
  • If positive, vancomycin + cefazolin for peri-operative prophylaxis
Thank you