Infection Control:
Blood Stream Infections

Infectious Disease Epidemiology Section
Office of Public Health
Louisiana Dept of Health & Hospitals
800-256-2748
www.oph.dhh.louisiana.gov

Your taxes at work
Intra Vascular Access: Short Term

- Peripheral venous catheter
  Rare BSI if removed within 4 days

- Peripheral arterial catheter
  BSI risk 3-13 / 1,000 cath-days

- Non-tunneled central venous catheter
  inserted into subclavian vein or jugular vein
  90% of all CR-BSI

- Pulmonary artery catheter
  monitor hemodynamic parameters
  average 3 days

- Catheters (thin, flexible hollow tubes) with one end positioned outside the body
- Ports surgically placed under skin require special needle for access
- Opposite end of the tubing is positioned within the large vein near the heart

5 million placed in USA yearly

Short term < 8 days
Intermediate 8 - 29 days
Long Term >30 days
Intra Vascular Access: Long Term

- Tunneled central venous catheter
  Surgically implanted into subclavian or jugular vein
  Subcutaneous tissue grows in polyester fiber cuff surrounding stabilizing catheter
  Hickman, Broviac, Groshong

  Hickman, Groshong w Dacron cuff inside exit site to inhibit migration of skin organisms into catheter tract

- Totally implantable device
  Inserted into subclavian or jugular vein
  Attached to a fluid reservoir placed in surgically created subcutaneous pocket on upper chest, or into an arm vein with a peripheral port pocket

- Peripherally inserted central venous catheter (PICC)
  Inserted via peripheral vein of upper arm into superior vena cava
Central venous Access Devices
Colonization

• Microbial growth occur
  • Endoluminal
  • External catheter surface under skin

• Semiquantitative culture: $\geq 15 \text{ CFU} / \text{segment}$

• Quantitative: $\geq 100 \text{ CFU}$
CFU Counts

- **Segments** = distal 5cm tip or proximal 5cm subcutaneous

- **Qualitative method**
  - Drop segment in broth
  - Incubate 2-3 days
  - Culture pos or neg

- **Semiquantitative or roll plate method:**
  - Roll segment 4 times on sheep agar
  - Incubate 3 days
  - Count

- **Quantitative method:**
  - Drop segment in 1 mL broth, sonicate to loosen microbes
  - Serial dilutions plated
  - Incubate
  - Count
Local catheter infection

• Exit site infection:
  • Purulent drainage from catheter exit site
  • Or erythema, tenderness & swelling within 2cm of catheter exit site

• Port pocket infection
  • Erythems & necrosis over reservoir of totally implantable device
  • Or purulent exudate in subcutaneous pocket containing reservoir

• Tunnel infection:
  • Erythema, tenderness & swelling of tissue overlying catheter more than 2cm from exit site

• Differentiate infection from simple phlebitis due to local inflammation. Physico-chemical phlebitis occur in 30% peripheral venous cath in 2-3 days
Transient Bacteremia

- Very common:
    - 7% transient bacteremias in 2000 blood cultures
    - StaphCoagNeg 40%, StrepViridans 30%
  - Best practices: 2-3%

- Risk factors
  - Dental procedures: from tooth brushing, to extraction
  - Intubation
  - Lacrymal duct probing
  - Burn wound manipulation
  - GI endoscopy, Ba enema
  - Dermato surgery
  - Urologic endoscopy
  - IUD replacement

- Need for antibiotic prophylaxis?
Transient Bacteremia

Detection: Look at

• Clinical presentation: Signs and symptoms...

• Microbe recovered:
  • Does it match patient profile ?
  • Disease profile ?

• Number of positive cultures
Primary Lab Confirmed BSI
1 - Pathogen

- Recognized pathogen from 1 or more blood culture
- Not related to infection at other site
Primary Lab Confirmed BSI 2 - Contaminant

- One of following:
  - Fever > 38 °C
  - or chills
  - or hypotension <90mm

- AND Common skin contaminant
  - from 1 or more blood cultures
  - Drawn on separate occasions

- AND Common skin contaminant
  - from 2 or more blood cultures
  - With I vasc line
  - Tx prescribed for infection

- AND positive antigen in blood for
  - *Hemophilus influenzae*
  - Or *Neisseria meningitidis*
  - Or group B streptococci
Primary Lab Confirmed BSI 3 - Pediatric

- One of following:
  - Fever >38 °C rectal
  - or hypothermia <37 °C
  - Or apnea
  - Or bradycardia

- AND Common skin contaminant
  - from 2 or more blood cultures
  - Drawn on separate occasions

- AND Common skin contaminant
  - from 1 or more blood cultures
  - With I vasc line
  - Tx presctibed for infection

- AND positive antigen in blood for
  - *Hemophilus influenzae*
  - Or *Neisseria meningitidis*
  - Or group B streptococci
Clinical Sepsis

**ADULT**
- One of following:
  - Fever >38 °C
  - or hypotension <90mm
  - Or Oliguria <20mL/ hr
- AND no blood culture or negative blood culture
- AND no infection related to other site
- AND Tx ordered for sepsis

**PEDIATRIC**
- One of following:
  - Fever >38 °C rectal
  - or hypothermia <37 °C
  - Or apnea
  - Or bradycardia
- AND no blood culture or negative blood culture
- AND no infection related to other site
- AND Tx ordered for sepsis
Secondary BSI

- Recognized pathogen from 1 or more blood culture
- Related to infection at other site
Catheter Related Blood Stream Infection (BSI)

- Similar microorganism in catheter colonization and blood culture
- Clinical evidence of BSI
  - Fever or hypothermia
  - ± hypotension, tachycardia, tachypnea, confusion
Source of Infection
Cath as Source of Infection

- Similar microbes from cath and BSI
- Blood drawn thru cath >100 CFU / mL
- Or comparison blood drawn thru catheter and blood drawn from peripheral vein with ratio of 8:1
- Other ratio were used (3:1) or absolute difference (30 CFU)
- Or timing: blood thru cath positive > 2 hours before other peripheral vein
- 70% of CVC-BSI show no local signs around cath
Source of Infection

- Thrombin sheath covers internal & external surface of cath rich in host protein:
  - Fibronectin (S.a. & S.e.)
  - Fibrinogen (S.a.)
  - Collagen...

- Some S.a. & Candida produce exopolysaccharide causing biofilm to form
- Biofilm may protect from antibiotics

- Material important:
  - S.a. prefers silicone to polyurethane, teflon or PVC
Source of Infection

• Colonization of central venous cath is universal within 24 hrs (Raad I 1997),
  BUT only a few cause infection

• Short term cath:
  • from skin at cath entry
  • Moving under skin along surface
  • May cause local or BSI

• Long term cath (>3 weeks): from cath hub to lumen ⇒ BSI
  (Raad I 1997. JID 168: 400-407)
BSI Risk Factors: Catheter Type

- Peripheral I-Venous Cath: low risk
- Peripherally Inserted Central cath (PICC) low risk
- Central Venous Cath (CVC): 2% of cath, 97% of CR-BSI
- Total Parenteral Nutrition IF improperly used
- TPN with lipid infusions (S.epi)
- TPN for use other than parenteral nutrition
- Femoral > Jugular > subclavian vein
- Inserter inexperience
- Transparent dressings
- Antibiotic ointment ⇒ / 2 bacterial, x5 fungal infection
Risk Factors
Technical Risk Factors

- Skin preparation:
  - Tincture of iodine
  - Alcoholic chlorhexidine
  - Povidone iodine
- Sterile glove
- New needle each attempt
- Quick transfer to bottle
- Quantity of blood
  - Concentration in blood usually < 1 CFU / mL
  - > 10 mL up to 20 mL
- Timing between two cultures not so important
- Location: not cath site
Personal Risk Factors

• Severity of disease (APACHE score)
• ICU: risk *10
• Neutropenia / oncology patients
• Chronic liver disease / cirrhosis
• Burn
• Spinal cord injury
• Hemodialysis
• Organ transplant recipient
Personal risk Factors

- Old age
  - 0.3 / 1,000 pt.days in Nhomes
  - Case Fatality 20-30%
  - *E.coli* 25%, Proteus 15%, *Staph. aureus* 10%
  - UTI 50%, RTI 10%

- Neonates
  - Early / Late onset post delivery
  - Low birth weight
  - Ivasc Cat 3-10 / 1,000 CVC days
  - StaphCoagNeg, *Staph. aureus*, *E.coli*, Pseudom, Candida
Incidence
Incidence

• 150 million catheter sold yearly in USA

• 3 million central venous cath (CVC)

• Increased cath use ⇒ increased incidence:
  
  • Percent of Nosocomial infection: 1975 = 5%
    2000 = 14%

  • Overall incidence: 1975 = 2-4 / 1,000 discharges
    2000 = 10-15 / 1,000 discharges
Incidence

- Peripheral intravenous cath < 1 / 1,000 cath.days
  < 1 / 1,000 insertions
- Arterial catheter 1 to 4 / 100 insertions
- Short term central venous cath 1 to 4 / 100 insertions
- Long term central venous cath 1 to 2 / 1,000 cath.days
Microbes
CR-BSI Agents

- *Staph. epidermidis* (coag neg) 28%
- *Staph. aureus* 26%
- Candida 17%
- Enterobacter 7%
- Serratia 7%
- Enterococci 5%
- Klebsiella 4%
- Pseudomonas 3%

- Association cath colonization / BSI vary
  - Candida 68%
  - *S. aureus* 60%
  - *S. epi* 32%
# Resistance among BSI Agents

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>ICU</th>
<th>Non ICU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staph. coag neg - MRSE</td>
<td>75%</td>
<td>65%</td>
</tr>
<tr>
<td>\textit{Staph. aureus} - MRSA</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>Enterococci - Vanco R</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>Pseudomonas aer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FQuinolone</td>
<td>26%</td>
<td>25%</td>
</tr>
<tr>
<td>Imipenem</td>
<td>20%</td>
<td>12%</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>15%</td>
<td>8%</td>
</tr>
<tr>
<td>Piperacillin</td>
<td>17%</td>
<td>12%</td>
</tr>
<tr>
<td>Enterobacter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cef-3</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>\textit{E.coli}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cef-3</td>
<td>6%</td>
<td>5%</td>
</tr>
</tbody>
</table>