Surgical Infections

UTCHS
Department of Surgery

Double Edged Sword

- Appropriate use
  - prevent infection
  - eradicate infection
- Inappropriate use
  - organ injury
  - superinfection
  - resistant organisms

Adverse Events

Harvard Medical Practice Study II

- 30,195 hospital records
- 1,133 patients (3.7% disabling injuries
- Drug complications most common type

Impact of ADE's

- Linear regression (LOS & Cost):
  ADE = 1.9 days, $2,262 (p < .001)
- Logistic regression (mortality)
  = 1.88 (C.I. 1.54 - 2.22; p < .001)

Complication

ADE's in 2.43 Per 100 Admits

<table>
<thead>
<tr>
<th></th>
<th>ADE</th>
<th>Controls</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality (%)</td>
<td>3.5</td>
<td>1.05</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>7.49</td>
<td>4.48</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Cost ($)</td>
<td>10,010</td>
<td>5355</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

Drug-Related Adverse Events

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Weighted %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotic</td>
<td>16.2</td>
</tr>
<tr>
<td>Antitumor</td>
<td>15.5</td>
</tr>
<tr>
<td>Anticoagulant</td>
<td>11.2</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>8.5</td>
</tr>
<tr>
<td>Antiseizure</td>
<td>8.1</td>
</tr>
<tr>
<td>Diabetes</td>
<td>5.5</td>
</tr>
<tr>
<td>Antihypertensive</td>
<td>5.0</td>
</tr>
<tr>
<td>Analgesic</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Leape, et al., NEJM 1991
Preoperative Antibiotics

- Usually IV, but consider oral antibiotics and "mechanical" cleansing for colon
  - frequently use combination
- Continue antibiotics if already infected
- Consider source of contamination
  - i.e. skin vs. GI tract
- Topical – Ineffective
- Don’t use if continued contamination
  - i.e. trach, foley, central line, burns

Types of Infections

- Cellulitis (skin) well-demarcated
  - Clostridium
  - Streptococcus
- Abscess (superficial)
  - above waist – Staph
  - below waist – mixed flora

Necrotizing Soft Tissue Infection

- Clostridial Myonecrosis -
  - No erythema
  - Mild swelling
  - Thin exudate
  - Crepitus
  - Hyperesthesia
  - Gangrene
  - Lack of well-demarcated boundaries (vs. cellulitis)

Necrotizing Soft Tissue Infection

- Non-Clostridial Myonecrosis -
  - Dishwater to purulent drainage
  - Mild erythema
  - Swelling
  - Gangrene
  - Bullae
  - Crepitus
  - SQ ± fascia ± muscle > skin

Treatment

- Cellulitis
  - Above waist - cephalizin
  - Below waist - Unasyn, Zosyn, etc.
- Skin Abscess
  - I & D then above

Treatment

- Clostridial myonecrosis
  - OPERATIVE DEBRIDEMENT
  - PCN G + Clindamycin or 3rd generation cephalosporin + clindamycin
- Non-clostridial myonecrosis
  - OPERATIVE DEBRIDEMENT
  - Broad spectrum- Unasyn, Zosyn, etc.
Superficial Wound Infection

- Usually staph/strep
- May include organisms from entered organ
- Routine culture not helpful or indicated
- Treatment is to OPEN WOUND
- No antibiotics unless accompanying cellulitis

Post-Operative Fever Chronology

<table>
<thead>
<tr>
<th>DAY</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7</td>
<td>&quot;Wind&quot; (atelectasis)</td>
</tr>
<tr>
<td>~3</td>
<td>&quot;Water&quot; (UTI)</td>
</tr>
<tr>
<td>~5</td>
<td>&quot;Wound&quot; (superficial wound infection), &quot;Walk&quot; (DVT)</td>
</tr>
<tr>
<td>~7</td>
<td>&quot;Wonder Drug&quot; (antibiotics), Intraabdominal abscess</td>
</tr>
</tbody>
</table>

Definitions

- All post op infections in site of surgery are "surgical site infections"
  - Superficial
    - Skin
    - Subcutaneous tissue
  - Deep incisional – fascia and muscle
  - Organ space
    - Intraabdominal
    - Empyema
    - Mediastinitis

Infection Factors

- Virulence and # bacteria
  - Strep, clostridia (exotoxins)
    - need smaller inocula
  - Gram negative (endotoxins)
    - systemic effects
- If inocula > $10^5$ – usually get infection

Local Wound Risk Factors

- Foreign bodies
- Poor approximation of tissue
- "Strangulation" of tissue with sutures, etc.
- Hematoma
- Seromas

Patient Risk Factors

- Extremes of age
- Low blood flow, i.e. shock, PVD
- ? Hypothermia
- Uremia, steroids
- Cancer
- Trauma
- Malnutrition
- Long preoperative hospital stay
- Diabetes
**Wound Classification**

- Clean
  - non trauma
  - no GI, GU, or respiratory tract involvement
  - 1.5 - 2.9% infection incidence
- Clean – contaminated
  - GI or respiratory tract cut without significant spillage
  - Oropharynx, vaginal, biliary, or GU (non infected)
  - Minor technical break
  - 2.8 - 7.7% infection incidence

- Contaminated
  - Major technical break
  - 6.4 - 15.2% infection incidence
- Dirty
  - Trauma
  - GI with gross spillage
  - GU/biliary with infection
  - 7.1 - 40% infection incidence

**Operative Management**

- Debride dead tissue
- Don’t close infected wounds
  - must cover vessels, bone
- Monofilament suture better than braided
  - 1,000,000 staph needed for Infection If Injected
  - 10 staph needed if silk suture present

- If large space (hematoma or seroma potential) use a CLOSED suction drain
- Solution to pollution is dilution
- Consider delayed primary closure

**CDC Criteria**

- Superficial incisional SSI
  - Within 30 days
  - Pus, organisms
- Deep incisional SSI
  - Within 30 days
  - Pus, dehiscence, x-ray
- Organ / Space SSI
  - Within 30 days
  - Pus, organisms from organ space, x-ray

**Guideline Resources**

- [www.east.org](http://www.east.org)
- [www.guidelines.gov](http://www.guidelines.gov)
- [www.cdc.gov](http://www.cdc.gov)
- [www.surgicalinfection.org](http://www.surgicalinfection.org)
- [www.sccm.org](http://www.sccm.org)
### Evidence Rating Scheme

<table>
<thead>
<tr>
<th>Level I</th>
<th>large RCT or meta-analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level II</td>
<td>small RCT</td>
</tr>
<tr>
<td>Level III</td>
<td>cohort studies</td>
</tr>
<tr>
<td>Level IV</td>
<td>case control studies</td>
</tr>
<tr>
<td>Level V</td>
<td>uncontrolled studies</td>
</tr>
<tr>
<td>Level VI</td>
<td>conflicting evidence favoring recommendation</td>
</tr>
<tr>
<td>Level VII</td>
<td>expert opinion</td>
</tr>
</tbody>
</table>

### Gastrooduodenal Surgery

- Prophylaxis for patients at high risk (↑ pH, obstruction, bleeding, cancer).
  - When lumen entered → single dose cefazolin at induction
- Strength of evidence = A

### Biliary Tract Surgery

- Single dose cefazolin at induction for open procedures
- Strength of evidence = A
- Prophylaxis not recommended for laparoscopic cholecystectomy
- Strength of evidence = B

### Appendectomy

- For uncomplicated appendicitis, single dose cephalosporin (aerobic plus anaerobic: cefotetan, cefoxitin) at induction
- Alternative is metronidazole plus gentamicin
- Strength of evidence = A

### Colorectal Surgery

- Mechanical bowel preparation
- Oral neomycin sulfate (1g) and erythromycin base (1g) following bowel prep at 19, 18, and 9 hours before surgery
- Single 2g dose of cephalosporin (cefotetan, cefoxitin) at induction
- Strength of evidence = A
**Nontunneled CVC Infection**

**CVC Infection Management**

**Tunneled CVC Infection**

**Penetrating Abdominal Trauma**

- Single pre-op dose (aerobic & anaerobic)
  - absence of hollow organ injury requires no further administration
  - continuation for only 24 hours with hollow organ injury
  - Strength of evidence = A

**Infectious Complications**

**Risk Factors**

- Organ injury
- Hemorrhage and shock
- Degree of injury

**Antibiotic Choice**

- Cover colon flora
  - 20% have colon injury
- No specific agent / combination superior
- 2nd & 3rd generation cephalosporins
- Aminoglycoside / anaerobe specific
- Advanced spectrum penicillins
### Rates of Infection After Antibiotic Regimen

<table>
<thead>
<tr>
<th>Regimen</th>
<th># Pts.</th>
<th># (%) inf.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoglycoside, cephalothin</td>
<td>97</td>
<td>25 (26)</td>
</tr>
<tr>
<td>Cefamandole</td>
<td>229</td>
<td>45 (20)</td>
</tr>
<tr>
<td>Doxycycline, penicillin</td>
<td>81</td>
<td>16 (20)</td>
</tr>
<tr>
<td>Aminoglycoside, clindamycin</td>
<td>878</td>
<td>122 (14)</td>
</tr>
<tr>
<td>Cefoxitin</td>
<td>578</td>
<td>80 (14)</td>
</tr>
<tr>
<td>Aminoglycoside, metronidazole</td>
<td>80</td>
<td>10 (13)</td>
</tr>
<tr>
<td>Carbenicillin</td>
<td>90</td>
<td>11 (12)</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>368</td>
<td>35 (10)</td>
</tr>
<tr>
<td>Moxalactam</td>
<td>278</td>
<td>20 (7)</td>
</tr>
</tbody>
</table>

*Dellinger, RID 1991*

### Antibiotic Utilization

**Duration of Administration**

- Prolonged → toxicity, resistance, costs
- Short → higher infections?
- Prolonged for high risk?

### Infection Rate & Duration of Antibiotic Administration

<table>
<thead>
<tr>
<th>Duration</th>
<th># Patients</th>
<th># (%) Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 24 hours</td>
<td>572</td>
<td>71 (12)</td>
</tr>
<tr>
<td>2 days</td>
<td>652</td>
<td>61 (9)</td>
</tr>
<tr>
<td>3 days</td>
<td>431</td>
<td>70 (16)</td>
</tr>
<tr>
<td>5 days</td>
<td>568</td>
<td>77 (14)</td>
</tr>
<tr>
<td>7 days</td>
<td>174</td>
<td>16 (9)</td>
</tr>
</tbody>
</table>

*Dellinger, RID 1991*

### Major Infection Rates

<table>
<thead>
<tr>
<th>Group</th>
<th>1 Day (118)</th>
<th>5 Day (117)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (%)</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Colon (%)</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>ATI ≤ 25 (%)</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>ATI &gt; 25 (%)</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

*Fabian, et al., Surgery 1992*

### Duration of Therapy - *abdominal infection* -

- Should be set at initial intervention based on operative findings
- Limited to 5 (Level 2) to 7 (Level 3) unless impossible to achieve source control
- Clinical signs of infection after 5 days should prompt diagnostic intervention, not continuation of antibiotics

### Antibiotics - *abdominal infection*

<table>
<thead>
<tr>
<th>Single Agents</th>
<th>Combo Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>cefoxitin</td>
<td>amino + anaerobe</td>
</tr>
<tr>
<td>ceftotan</td>
<td>cefuroxime + metronidazole</td>
</tr>
<tr>
<td>amp/sulbactam</td>
<td>3rd gen cef + anaerobe</td>
</tr>
<tr>
<td>ticarcillin/clavulan</td>
<td>ztreonam + clinda</td>
</tr>
<tr>
<td>pip/tazo</td>
<td>ciproflo + metrolax</td>
</tr>
<tr>
<td>Imipenem</td>
<td></td>
</tr>
<tr>
<td>meropenem</td>
<td></td>
</tr>
</tbody>
</table>

*None is superior (Level 1)*
High Risk Patient
- abdominal infection -

<table>
<thead>
<tr>
<th>Age</th>
<th>Nutrition</th>
<th>Comorbidities</th>
<th>APACHE II</th>
</tr>
</thead>
<tbody>
<tr>
<td>All associated with Tx failure &amp; death (Level I)</td>
<td>Routine addition of amino no indicated (Level 2)</td>
<td>Empiric antifungal Tx reasonable (Level 2)</td>
<td></td>
</tr>
</tbody>
</table>

Risks for Fungal Infections

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad spectrum atb.</td>
<td>201</td>
<td>26</td>
</tr>
<tr>
<td>Cancer</td>
<td>168</td>
<td>21</td>
</tr>
<tr>
<td>AIDS</td>
<td>108</td>
<td>14</td>
</tr>
<tr>
<td>Leukemia/Lymphoma</td>
<td>103</td>
<td>13</td>
</tr>
<tr>
<td>Diabetes</td>
<td>81</td>
<td>10</td>
</tr>
</tbody>
</table>

Summary

- More is not better
- Prophylaxis never more than 24 hours
- CVC infection = line removal
- ATB > 24 hours not indicated for PAT
- Empiric Tx based on most likely organisms

Ann Pharmacother, 1994