Antibiotics in the Surgical Patient

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Objectives

• Define current prophylactic recommendations for the use of antibiotics in the surgical patient

• List current antibiotics available and alternative antimicrobials, in addition to pharmacokinetic considerations for the surgical patient

• Verbalize considerations for the continued use of antibiotics in the post-surgical patient
Introduction

- Approximately 23 million surgical procedures are performed per year in the U.S.
- Post operative infection rate = 6%
- > 1 million surgical wound infections/year
- 25% of all nosocomial infections are related to surgical wounds
• Surgical wound infections increase health care costs by about 1.5 billion dollars/year

• Prophylactic antibiotics have been shown to decrease the risk of infection for many procedures and represents an important component of optimal management of the surgical patient.
• Controversies regarding prophylactic antibiotic use include:
  • Selection of antibiotic therapy
  • Duration of antibiotic therapy
  • Development of bacterial resistance
  • Role of newly developed antibiotics

• Factors resulting in failure of prophylaxis:
  • Inadequate timing of antibiotic
  • Failure to readminister antibiotic for prolonged procedures
Patient Risk Factors

- Extremes of age
- Nutritional status
- Obesity
- Diabetes
- Tobacco use
- Co-existent remote body site infections
- Altered immune system
- Corticosteroid therapy
- Recent surgical procedure
- Length of preoperative hospitalization
- Colonization with microorganisms
Definitions

• **Prophylaxis**
  • Administration of an antibiotic prior to contamination of previously sterile tissues or fluids (the use of antimicrobials for dirty and contaminated procedures is not considered prophylaxis)

• **Presumptive therapy**
  • Administration of an antibiotic when there is a strong possibility, yet unproven infection

• **Treatment**
  • Administration of an antibiotic when an established infection has been identified
“Dirty Procedures”

• Established infection
• Therapeutic course of antibiotics is require and is no longer considered prophylaxis
• Significant bacterial spillage from a ruptured viscus
• Requires antibiotic with broad spectrum activity
Ideal Agent

- Prevent surgical site infections
- Prevent surgical site infection related morbidity and mortality.
- Reduce the duration and cost of health care
- Produce no adverse effects
- Minimize consequences for the microbial flora for the patient or the hospital
- Agent should be active against pathogens most likely to contaminate the wound
- Given in an adequate dosage and at a time that ensures adequate tissue concentration during the period of potential contamination
- Safe
- Administered for the shortest effective period to minimize adverse effects, development of resistance, and cost.
Understanding Antibiotics

- Pharmacokinetics/Metabolism/Excretion/ Safety in pregnancy
- Methods of Administration
- Dosing intervals
- Mechanisms of action
- Tissue distribution
- Length of therapy
- Concurrent medications and medical conditions
- Risk and Benefits
Antibiotic Selection

• Nose
  • S. Aureus *, Pneumococcus, Meningococcus

• Skin
  • S. Aureus*, S. Epidermidis

• Mouth/Pharynx
  • Streptococci, Pneumococcus, E. Coli, Bacteroides, Fusobacterium, Peptostreptococcus

• Urinary Tract
  • E. Coli, Proteus, Klebsiella, Enterobacter
• GI Tract/Colon,
  • E. Coli, Klebsiella, Enterobacter, Bacteroides spp., Peptostreptococcus, Clostridia

• Biliary Tract
  • E. Coli, Klebsiella, Proteus, Clostridia

• Vagina
  • Streptococci, Staph spp., E. Coli, Bacteroides spp., Peptostreptococcus

• Upper Respiratory Tract
  • Pneumococcus, H. Influenzae
The Most Common

- Cefazolin/Cefotetan/Cefoxitin
- Vancomycin (only G+ coverage)
  - Can add Genatamicin/Aztreonam/Fluroquinolone to broaden coverage
- Clindamycin + aminoglycoside or aztreonam
## Antimicrobial Preoperative Prophylaxis Guidelines

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>PROCEDURE</th>
<th>ADULT DOSAGE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal</td>
<td>Gastroduodenal surgery in patients with hemorrhage, cancer, obstruction, or other high-risk features</td>
<td>Cefazolin 1–2 g IV preoperatively or Clindamycin 600 mg plus gentamicin 120 mg IV preoperatively</td>
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<tr>
<td>Gastric bypass</td>
<td></td>
<td>Cefazolin 1–2 g IV preoperatively</td>
</tr>
<tr>
<td>Percutaneous gastrostomy</td>
<td></td>
<td>Cefazolin 1–2 g IV preoperatively</td>
</tr>
<tr>
<td>Biliary tract (including ERCP) in patients who have acute symptoms, jaundice, or other high-risk features or who have had previous surgery</td>
<td>Cefazolin 1–2 g IV preoperatively or Gentamicin 80 mg IV preoperatively and q 8 h for 3 doses</td>
<td></td>
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<tr>
<td>Appendectomy (without perforation)</td>
<td></td>
<td>Cefoxitin, cefotetan, or cefmetazol 1–2 g IV preoperatively and q 6 h for 3 doses or Metronidazole 500 mg IV plus gentamicin 1.5 mg/kg IV preoperatively</td>
</tr>
<tr>
<td>Colorectal surgery, elective</td>
<td>Neomycin 1 g plus erythromycin base 1 g po at 1, 2, and 11 pm on the day before surgery ± parenteral drugs listed below for emergency colorectal surgery</td>
<td>Cefoxitin, cefotetan, or cefmetazole 2 g IV preoperatively and q 4 h for 3 doses or Metronidazole 500 mg IV plus gentamicin 1.7 mg/kg IV preoperatively and q 8 h for 3 doses</td>
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# Antimicrobial Preoperative Prophylaxis Guidelines

<table>
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<tr>
<th>Procedure</th>
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| **Cardiac**                   | Cefazolin 2 g IV preoperatively and q 4–6 h intraoperatively  
                                | *or* Cefuroxime 1.5 g IV preoperatively and q 4–6 h intraoperatively  
                                | *or* Vancomycin 1 g IV preoperatively |
| Median sternotomy, coronary   |                                         |
| artery bypass graft surgery,  |                                         |
| valve surgery, or pacemaker   |                                         |
| insertion                     |                                         |
| **Neurosurgery**              | Vancomycin 1 g IV plus gentamicin 1.5 mg/kg IV preoperatively  
                                | *or* Cefazolin 1 g IV preoperatively |
| Craniotomy, high-risk only    | Trimethoprim 160 mg IV plus sulfamethoxazole 800 mg IV preoperatively and q 12 h for 3 doses  
                                | *or* Vancomycin 10 mg plus gentamicin 3 mg injected into a cerebral ventricle |
| (eg, reexplorations, micro-   |                                         |
| surgery, entry into sinuses or |
| nasopharynx)                  |                                         |
| CSF shunt placement—only in  |                                         |
| hospitals with high infection |                                         |
| rates (15–20%)                |                                         |
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<td>Noncardiac thoracic</td>
<td>Pneumonectomy, lobectomy, other resections, or esophageal surgery</td>
<td>Cefazolin 1–2 g IV preoperatively and q 6 h for 24 h</td>
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<tr>
<td></td>
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<td>or</td>
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<td></td>
<td></td>
<td>Vancomycin 1 g IV preoperatively</td>
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<tr>
<td>Obstetric-gynecologic</td>
<td>Cesarean delivery, high-risk only (eg, premature rupture of membranes)</td>
<td>Cefazolin 1 g IV after clamping cord and q 6 h for 2 doses</td>
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<tr>
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<td>Abortion, 2nd-trimester instillation</td>
<td>Cefazolin 1 g IV preoperatively and q 6 h for 2 doses</td>
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<tr>
<td></td>
<td>Abortion, 1st trimester in patients with a history of pelvic inflammatory disease, gonorrhea, or multiple partners</td>
<td>Penicillin G 1–2 million units IV preoperatively and 3 h later</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or</td>
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<td></td>
<td></td>
<td>Doxycycline 100 mg po before the procedure and 200 mg 1/2 h afterward</td>
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<tr>
<td></td>
<td>Hysterectomy, vaginal or abdominal</td>
<td>Cefazolin 1 g IV preoperatively and q 6 h for 2 doses</td>
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<td>or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Doxycycline 200 mg IV preoperatively</td>
</tr>
<tr>
<td>Ophthalmic</td>
<td>Extraction of lens, with or without insertion of prosthesis</td>
<td>Gentamicin, tobramycin, or neomycin-gramicidin-polymyxin B drops over 2–24 h plus cefazolin 100 mg subconjunctivally at the end of the procedure</td>
</tr>
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<th>Orthopedic</th>
<th>Arthroplasty, including replacements</th>
<th>Cefazolin 1–2 g IV preoperatively and q 6 h for 3 doses or Vancomycin 1 g IV preoperatively</th>
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<td>Open reduction of fractures</td>
<td>Cefazolin 1 g IV preoperatively and as a single postoperative dose</td>
</tr>
<tr>
<td>Lower-extremity amputation (nonischemic)</td>
<td></td>
<td>Cefoxitin 2 g IV preoperatively and q 6 h for 4 doses</td>
</tr>
<tr>
<td>Otolaryngologic</td>
<td>Major head and neck surgery involving mucosa of the oral cavity or pharynx</td>
<td>Cefazolin 1–2 g IV preoperatively and q 8 h for 2 doses or Clindamycin 600–900 mg IV ± gentamicin 1.5 mg/kg IV preoperatively and q 8 h for 2 doses</td>
</tr>
<tr>
<td>Urologic</td>
<td>Prostatectomy if bacteriuria is present</td>
<td>Cefazolin 1 g IV preoperatively or another drug selected based on susceptibility tests</td>
</tr>
<tr>
<td></td>
<td>Penile prosthesis insertion</td>
<td>Cefazolin 1 g IV preoperatively</td>
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## ANTIMICROBIAL PREOPERATIVE PROPHYLAXIS GUIDELINES

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<tr>
<td>Vascular</td>
<td>Lower-extremity or abdominal arterial surgery or lower-extremity amputation for ischemia</td>
<td>Cefazolin 1–2 g IV preoperatively and q 6 h for 24 h or Vancomycin 1 g IV preoperatively and 12 h after the procedure</td>
</tr>
</tbody>
</table>

*Drugs, dosages, routes, and frequencies given represent current expert recommendations. Cefazolin remains highly favored because of its spectrum of bactericidal activity, long half-life, low cost, and low toxicity. Alternatives are primarily for patients with β-lactam allergies.

± = with or without.

Antimicrobial Selection

• Development of Resistance
  • MRSA
    – 49.2% of surgical wound infections (2008)
      (National Healthcare Safety Network)
    – Concern for VRSE/VRSA
  • VRE
    – 33% (2007)
  • Routine use of Vancomycin antimicrobial prophylaxis is not recommended for any procedure
    – Agent of choice when a cluster or high rate (>20%) of surgical wound infections in a institution isolate MRSA/CoAg (-) Staph spp.
• Patient Colonization
  • Bacterial flora most affected (but not limited to)
    » C. Difficile
    » Enterococci
    » Pseudomonas spp.
    » Serratia spp.

Universal screening of patients for MRSA/VRE is controversial
Administration

• Intravenously
  • Produces rapid, reliable and predictable serum and tissue concentration

• Orally

• Topically
Timing of the initial dose

• Preoperative administration within 2 hours prior to the incision decreased the risk of surgical site infections to 0.59% from:
  • 3.8% (2 – 24 hours) prior to the incision

• Overall the recommended timing should be with 60 minutes of the surgical incision
  (Vancomycin/Fluoroquinolones should begin within 60 – 120 minutes prior to incision)
Dosing

• Pharmacokinetic
• Pharmacodynamic properties
• Patient factors
  • Obesity has been recognized as a risk factor for surgical site infection; therefore “normal” dosing may be inadequate

• No conclusive recommendation for weight-based dosing for prophylaxis in adults
Redosing

• If a short acting agent is used, antibiotic should be redosed if the procedure extends beyond 3 hours
• Prolonged and excessive bleeding
• Anything that may shorten the half-life of the antimicrobial (eg. extensive burns)
• Not warranted if the half-life is prolonged (renal failure/insufficiency)
Duration

• For most procedures:
  • 24 hours or less

• Cardiothoracic
  • Up to 48 hours

• Ophthalmic
  • Duration not clearly established

• No data to support the continuation of antimicrobial prophylaxis until all drains, invasive lines or indwelling catheters are removed
Irrigations/Topicals/Washes

• Topicals generally only used in ophthalmic procedures

• Limited good data on the use of topicals, irrigations and washes

• Mupirocin decolonization?

• There is some interest in the use of topical Gentamicin or Vancomycin in cardiothoracic procedures to prevent mediastinitis, but data is still limited
Mechanical Bowel Prep

• No longer recommended for routine use in elective procedures
• No benefit for the use of MBP without oral or appropriate IV antimicrobials in elective colorectal procedures
Endocarditis Prophylaxis

- Procedures resulting in bacteremia increasing at risk patients for the development of endocarditis
- Who should receive:
  - Patients with artificial heart valves
  - Patients who have had heart repairs using prosthetic material (does not include coronary artery stents)
  - Patients with a prior history of endocarditis
  - Certain unrepaired or incompletely repaired congenital heart defects
  - Heart transplant patients who have now developed valvular disease
• Prophylaxis is recommended only for:
  • Dental procedures involving manipulation of the gums or roots of teeth
  • Procedures of the respiratory tract
  • Procedures involving infected tissue
• Prophylaxis is no longer recommended for procedures of the gastrointestinal or genitourinary systems.

• It is worth noting that the current guidelines do not recommend prophylaxis for:
  • Most patients with aortic or mitral valve disease (including MVP)
  • Patients with hypertrophic cardiomyopathy


