Surgical Antibiotic Prophylaxis

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Objectives

• Discuss antibiotic use as prophylaxis vs presumptive therapy vs treatment of infections.
• Discuss risk factors for developing a surgical wound infection.
  – Surgical wound classification and related risk of infection
• Discuss selection and administration of antibiotic therapy for surgical procedures.
• Discuss duration of antibiotic therapy for prophylaxis

Introduction

• Approximately 46 million surgical procedures are performed per year in the United States.
• Surgical site infections develop in 3-6% of patients
• > 2 million surgical wound infections per year
• 16% of all nosocomial infections are related to surgical wound infections
  – Several of these infections are preventable
Introduction

- Surgical wound infections increase health care costs by 5-10 billion dollars per year
  - Prolonged hospitalization stay
  - Increased morbidity/mortality
- 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.
  - Surgical antibiotic prophylaxis is well established and common practice.

Introduction

- Controversies regarding prophylactic antibiotic use include:
  - Selection of antibiotic therapy
  - Duration of antibiotic therapy
  - Development of bacterial resistance
  - Role of newly developed antibiotics
- Common factors resulting in failure of prophylaxis
  - Inadequate timing of antibiotic
  - Failure to re-dose antibiotic for prolonged surgical procedures

Definitions

- Prophylaxis:
  - Administration of an antibiotic prior to contamination of previously sterile tissues or fluids.
- Presumptive therapy:
  - Administration of an antibiotic when there is a strong possibility but unproven established infection
- Treatment:
  - Administration of an antibiotic when an established infection has been identified.
Definitions

• Surgical wound infections (SWI):
  – Infections identified by purulent or culture positive drainage isolated from any structure above the fascia in proximity to the surgical wound
  – Deep infections are characterized by purulent drainage from subfascial drains, wound dehiscence, or abscess formation and involve adjacent sites manipulated during surgery.
  – Wound Dehiscence
  – Breakdown of the surgical wound

Wound Classifications

• Identifying patient risk
  – Even with adequate sterile techniques and potent antibiotics wound infections develop in 2-9% of all surgical procedures
  – Bacteria are found in 90% of surgical incisions despite all aseptic precautions.
  – The National Research Council (NRC) stratifies infection risk by surgical procedure
    • Clean
    • Clean-contaminated
    • Contaminated
    • Dirty
### Wound Classifications

**Clean**
- SWI risk (<2%)
- Elective surgery
- No acute inflammation or transection of gastrointestinal (GI) tract, oropharyngeal, genitourinary (GU), biliary or tracheobronchial tracts
- No break in aseptic technique
- Examples include:
  - Craniotomy, orthopedic surgery, cardiothoracic and vascular surgery
- Antibiotic use is controversial but routinely used

**Clean-contaminated**
- SWI risk (2-10%)
- Urgent or emergent case that is otherwise clean, controlled opening of GI, GU, oropharyngeal, biliary, or tracheobronchial tracts,
- Minimal spillage and/or minor aseptic technique break
- Examples include:
  - Invasive head and neck surgery, cholecystectomy, urologic procedure, hysterectomy, orthopedic surgery with prosthesis
- Antibiotics are administered for prophylaxis

**Contaminated**
- SWI risk (10-20%)
- Any procedure in which there is gross soiling of the operative field during procedure, as well as surgery of open traumatic wounds (< 4 hours old).
- Examples include:
  - Colorectal surgery with spillage, biliary or GU tract surgery in the presence of infected bile or urine and clean or clean-contaminated procedures marred by a major break in technique.
- Antibiotics are administered for prophylaxis
Wound Classifications

- Dirty
  - SWI risk (>30%)
  - Purulence or abscess present, preoperative perforation of GI, oropharyngeal, biliary, or tracheobronchial tracts, penetrating trauma > 4 hours old.
  - Examples include:
    - Perforated appendicitis with abscess formation
    - Antibiotics are utilized for treatment, therefore use is not considered prophylaxis

Surgical Wound Infections

Identified Risk Factors

- Incidence of a SWI depends on numerous factors specific to either the procedure itself or the individual patient.
  - Type of surgical procedure and bacterial load encountered
  - Underlying medical condition of the patient
  - Surgical procedure
    - Technique
    - Duration
    - Patient preparation
    - Equipment preparation
Patient Risk Factors

• Systemic Factors
  – Diabetes
  – Remote infections
  – Corticosteroids
  – Obesity
  – Extreme of age
  – Malnutrition
  – Massive transfusion
  – Multiple preoperative comorbid medical diagnosis (≥3)
  – ASA class 3, 4 or 5

ASA Risk Factors

• Local factors
  – Foreign body
  – Electrocautery
  – Injection with epinephrine
  – Wound drains
  – Hair removal with razor
  – Previous irradiation of site
Risk Factors

- Surgery-related factors
  - Type of procedure, site of surgery, emergent surgery
  - Duration of surgery (>60-120 min)
  - Previous surgery
  - Timing of antibiotic administration
  - Placement of foreign body
    - Hip/knee replacement, heart valve insertion, shunt insertion
    - Hypotension, hypoxia, dehydration, hypothermia

Risk Factors

- Surgery related factors
  - Patient preparation
    - Shaving the operating site
    - Preparation of operating site
    - Draping the patient
  - Surgeon preparation
    - Handwashing
    - Skin antiseptics
    - Gloving

Risk Factors

- Wound-related factors
  - Magnitude of tissue trauma and devitalization
  - Blood loss, hematoma
  - Wound classification
    - Potential bacterial contamination
  - Presence of drains, packs, drapes
  - Ischemia
  - Wound leakage
## Antibiotic Use

### Procedure | NNT
---|---
Open Heart Surgery | 14
Colorectal Surgery | 5
Head & Neck-Clean | NA
Head & Neck-Contaminated | 3
Total Hip replacement | 42
Hip Fracture Repair | 58

## Antibiotic Selection

- Characteristics of an optimal antibiotic for surgical prophylaxis
  - Effective against suspected pathogens
  - Does not induce bacterial resistance
  - Effective tissue penetration
  - Minimal toxicity
  - Minimal side effects
  - Long half-life
  - Cost effective

## Antibiotic Use

- Appropriate antibiotic use for prevention of SWI includes the following:
  - Appropriate timing of administered agents and repeated dosing based on length of procedure and antibiotic half-life
    - Consider re-dosing if procedure > 4 hours
  - Appropriate selection based on procedure performed
  - Appropriate duration to avoid infection and decrease potential for development of resistance
**Antibiotic Use**

- Antibiotic selection
  - Must be effective against organisms most likely to be encountered
    - Endogenous organisms related to type of surgical procedure performed
    - Exogenous organisms introduced secondary to poor surgical technique
  - Must provide adequate tissue penetration for effective concentrations
  - Avoid using broad spectrum agents when unnecessary
    - Widespread use facilitates development of resistance
    - 3rd generation cephalosporins have no role in prophylaxis

**Likely Pathogens**

- Head & Neck Surgery
  - *S. aureus, Streptococci*
- Skin
  - *S. aureus, S. epidermidis*
- Neurosurgery
  - *S. aureus, S. epidermidis*
- Cardiac & Thoracic Surgery
  - *S. aureus, S. epidermidis*

**Likely Pathogens**

- Gastroduodenal
  - Gram-positive cocci, enteric gram-negative bacilli
- Colorectal
  - Enteric gram-negative bacilli, anaerobes
- Gynecologic and obstetric
  - Enteric gram-negative bacilli, anaerobes, group B streptococcus
- Biliary
  - Enteric gram-negative bacilli
Antibiotic Selection

• Cefazolin is the most common agent utilized when skin flora is the source of contamination
  – All clean procedures
    • Cardiothoracic surgeries
    • Neurosurgical procedures
    • Orthopedic surgery
    • Vascular surgery
  – Several clean/contaminated procedures
    • Controlled opening of GI tract
    • Head and neck surgery

Antibiotic Selection

• Vancomycin
  – Utilized as prophylaxis in institutions in which methicillin resistant S. aureus (MRSA) and S. epidermidis (MRSE) are a frequent cause of postoperative wound infection
  – Utilized in patients with documented allergies to Penicillins and cephalosporins
  – Increased empiric use likely contributes to the development of vancomycin resistant enterococcus (VRE)

Antibiotic Selection

• Surgical procedures which enter the gastrointestinal, oropharyngeal, genitourinary, biliary, or tracheobronchial tracts and result in spillage of bacteria require increased gram negative and anaerobic coverage.
  – Cefoxitin or cefotetan alone
  – Clindamycin with aminoglycoside
  – Metronidazole with cefazolin
  – Broad spectrum agents are frequently utilized for prophylaxis as monotherapy
    • Unasyn, Timentin, Zosyn, Primaxin, Merrem
Antibiotic Selection

• Dirty procedures
  – Patient already has an established infection and requires a surgical procedure that is often times emergent.
  – Therapeutic course of antibiotics is required and is no longer considered prophylaxis
  – Ruptured appendix
    • Significant bacterial spillage results in an established intra-abdominal infection
    • Surgery required to remove remains of appendix
  – Requires broad spectrum activity
    • Unasyn, Timentin, Zosyn, Merrem, Primaxin

Antibiotic Selection

• Bacterial counts in the gastrointestinal tract vary depending on location
  – Esophagus and stomach
    • Normally <1000 organism/ml
  – Duodenum and jejunum
    • 100-10,000 organisms/ml
  – Ileum
    • 1-10 million organisms/ml
  – Colon
    • 2/3 dry fecal matter is bacteria (400-500 different species)

Antibiotic Use

• Oral prophylactic regimen to decrease bacterial colonization for elective colorectal surgery.
  – Mechanical bowel preparation
    • Use of Go-Lytely
  – Oral antibiotics
    • Erythromycin base and neomycin 1gm PO @ 1pm, 2pm and 11pm (for an 8 am surgery or 19, 18 and 9 hours preop
  – This regimen in addition to IV antibiotics (cefotixin or cefotetan) further reduces risk of post-operative infection
Antibiotic Use

• Timing of antibiotic administration
  – It is clear that antimicrobial prophylaxis is effective when administered prior to the first incision.
  • Antibiotic must be present in adequate concentrations in the tissues when bacterial contamination occurs.
  • Administration within 30-60 minutes of incision
  – Adequate antibiotic concentrations must be maintained throughout the surgical procedure
    • Dependent upon the length of surgery and antibiotic half-life
    • Re-dose antibiotic if surgical procedure exceeds 2 half-lives of drug utilized

Antibiotic Use

• Antibiotic duration
  – Few good clinical trials support the current guidelines related to the duration of prophylaxis
  – The duration of antibiotics should not exceed 48 hours
  – Clean surgery procedures, a single dose is generally appropriate
  – For clean-contaminated and contaminated procedures 24 hours duration is most commonly utilized and recommended

Endocarditis Prophylaxis

• Patients with underlying structural cardiac defects are at risk for developing endocarditis and antibiotic prophylaxis is recommended when bacteremia may occur during specific procedures
  – Presence of prosthetic cardiac valves
  – Previous bacterial endocarditis
  – Congenital cardiac malformations
  – Acquired valvular dysfunction (Rheumatic heart disease)
  – Mitral valve prolapse with regurgitation
Endocarditis Prophylaxis

- Procedures resulting in bacteremia increasing at risk patients for development of endocarditis
  - Dental and oral procedures
    - procedures likely to result in bleeding
    - Oral antibiotic regimens recommended
      - Amoxicillin 2 gm 1 hr before procedure, children = 50mg/kg
      - PCN allergic Clindamycin 600 mg (children 20 mg/kg), cephalaxin 2 gm (children 50 mg/kg), or azithromycin/clarithromycin 500 mg (children 15 mg/kg) 1 hr before procedure
    - Respiratory, GI and/or GU tract procedures

Summary

- Surgical prophylaxis can significantly reduce the incidence of post-operative wound infections
- Several appropriate antibiotics available for use
  - Cefazolin remains the most common agent used for prophylaxis
Summary

• Several risk factors contribute to wound infection
  – Patient related factors
  – Surgery related factors
  – Wound related factors
• Antibiotic use
  – Effective against suspected pathogens
  – Effective tissue penetration
  – Minimal toxicity

Summary

• Appropriate timing of administered antibiotics
  – Must be given 30-60 minutes before incision
  – Repeat dose if procedure is longer than two half-lives of antibiotic utilized
    • Rule of thumb = 4 hours
• Duration of use
  – Controversial
  – Does not need to be > 48 hours
  – 1 preop does utilized for clean procedures
  – 24 hours duration following procedure is most commonly utilized