Surgical Site Infection Prevention
Objectives

1. Discuss risk factors for SSI
2. Describe evidence-based best practices for SSI prevention
3. State principles of antibiotic prophylaxis
4. Discuss novel interventions to decrease SSI
Impact of SSI

- **Burden**
  - 2-5% of surgical patients develop SSI
  - Approximately 500,000 SSI in US annually

- **Outcomes**
  - 7-10 additional hospital days
  - 2-11 times higher risk of death
  - Majority of deaths are directly attributable to SSI
  - $3,000 - $29,000 excess cost per SSI
  - $10 billion annually in excess cost

Anderson et al. ICHE, 2008, 29 (S1)
Surveillance

- **National Healthcare Safety Network (NHSN)**
  - Formerly NNIS
  - CDC program that reports aggregated surveillance data from U.S. hospitals
  - Standardized definitions for infection and risk-stratification methodology
  - National data on pooled mean and percentiles
  - We use NHSN to perform SSI surveillance for surgical procedures including craniotomy, laminectomy, spinal fusion, C-section, and CABG
CDC Definitions of Surgical Site Infections

• SSI
  – occurs within 30 days after the procedure (or within 1 year if an implant)
  – has at least one of the following:
    • purulent drainage from the incision
    • organisms isolated from an aseptic culture of the incisional fluid or tissue
    • incision deliberately opened by the surgeon when the patient has signs or symptoms of infection such as pain, erythema, or edema (unless the culture is negative)
    • diagnosis of a superficial SSI made by the surgeon or attending physician
CDC Definitions of Surgical Site Infections

Horan et al. ICHE, 1992, 13:606
Risk Stratification

- ASA score (3,4 or 5)
- Duration of operation (>75\textsuperscript{th} percentile)
- Wound classification
  - CLEAN
  - CLEAN-CONTAMINATED
  - CONTAMINATED
  - DIRTY-INFECTED
Risk Factors for SSI

Host Factors
- Age
- Obesity
- Malnutrition
- Prolonged pre-operative stay
- Infection at distal sites
- Cancer
- Hyperglycemia
- Immunosuppression
- ASA class
- Comorbidities

Surgical/Environmental Factors
- Abdominal site
- Wound classification
- Duration of surgery
- Urgency of surgery
- Procedure
- Hair removal
- Intraoperative contamination
- Prophylactic antibiotics
- Surgical technique
- Surgical volume
- Prior procedures
- Poor hemostasis
- Drains/foreign bodies
- Hypothermia
- Oxygenation

Microbial Factors
- Nasal/skin carriage
- Virulence
- Adherence
- Inoculum
Strategies to Prevent SSI

- SSI prevention strategies target the:
  - Pre-operative period
  - Intra-operative period
  - Post-operative period
  - Intrinsic, patient-related factors
  - Extrinsic, procedural factors
Strategies to Prevent SSI

• Must consider whether any given SSI risk factor is:
  – Modifiable
    • Antimicrobial administration, glucose, temperature, hair removal, oxygenation, etc.
  – Not-modifiable
    • Age, co-morbidities, severity of illness, wound class, etc.
Existing Guidelines and Requirements

- Healthcare Infection Control Practices Advisory Committee (HICPAC) Guidelines
- CMS Surgical Infection Prevention Collaborative
- Surgical Care Improvement Project (SCIP)
- Institute for Healthcare Improvement (IHI)
- Federal requirements for reporting of quality data (CMS)
CMS Surgical Infection Prevention Collaborative

• Created in 2002
• 3 performance quality measures
  – Administration of antimicrobial prophylaxis within 1 hour prior to incision (2 hours for Vancomycin and fluoroquinolones)
  – Use of a recommended antimicrobial agent
  – Discontinuation of antimicrobial prophylaxis within 24 hours after surgery
• Hysterectomy; hip and knee arthroplasty; cardiac surgery, vascular surgery, colorectal surgery
Surgical Care Improvement Project (SCIP)

- Created in 2003
- Extension of Surgical Infection Prevention Collaborative
- In addition to the 3 antimicrobial prophylaxis measures, SCIP adds 3 more performance quality measures:
  - Proper hair removal (no razors)
  - Glucose control <200 mg/dL for 2 days after cardiac surgery
  - Maintenance of peri-operative normothermia for colorectal surgery
Interventions to Prevent SSI

• Hair Removal
  – No hair removal unless hair will interfere with the procedure
  – NO razor shaving, use clippers if necessary
  – If necessary, remove hair close to the time of surgery and outside the OR to prevent contaminating the OR environment
Shaving vs. Clipping

- Shaved 2.8% (46/1627) SSI vs. clipped 1.4% (21/1566) SSI, RR=2.02 (95%CI 1.21-3.36)
- Shaving must not be performed

Interventions to Prevent SSI

• Glucose control
  – Reduce hemoglobin A1c to <7% prior to elective surgery when possible
  – Control blood glucose levels during the peri-operative period
## Hyperglycemia: Abdominal and Cardiovascular Operations

<table>
<thead>
<tr>
<th>Glucose POD#1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;220 mg%</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>&gt;220 mg%</td>
<td>31%</td>
<td></td>
</tr>
</tbody>
</table>

**Any Infection**

**“Serious” Infection** 5.7-fold increase for any glucose > 220 mg%

Pomposelli. JPEN 1998;22:77
Interventions to Prevent SSI

• Temperature
  – One of the SCIP measures for colorectal surgery
  – One randomized controlled trial of 200 patients showed significantly lower SSI with normothermia during colorectal surgery
  – Hypothermia causes vasoconstriction, reduces oxygen tension, increases bleeding, and increase LOS even for un-infected patients
# Temperature and SSI Following Colectomy

<table>
<thead>
<tr>
<th></th>
<th>Normothermia</th>
<th>Hypothermia</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSI</td>
<td>6</td>
<td>18</td>
<td>.009</td>
</tr>
<tr>
<td>Collagen deposition</td>
<td>328</td>
<td>254</td>
<td>.04</td>
</tr>
<tr>
<td>Time to eat</td>
<td>5.6d</td>
<td>6.5d</td>
<td>&lt;.006</td>
</tr>
</tbody>
</table>

Kurz. NEJM 1996;334:1209
Interventions to Prevent SSI

• Antimicrobial Prophylaxis
  – Right agent
  – Right time
  – Right dose
  – Right duration
Antimicrobial Prophylaxis

• **Timing**
  – Administer within 1 hour prior to incision to maximize tissue concentration
  – 2 hours allowed for vancomycin and fluoroquinolones

• **Redosing**
  – Redose based on duration of procedure
  – Every 3-4 hours or as appropriate based on half-life of the agent
  – For every 1500 ml of blood loss
Give antibiotics within 60 minutes of incision

Antimicrobial Prophylaxis

• Duration
  – Stop antimicrobial prophylaxis within 24 hours after surgery
  – For cardiac surgery, stop antimicrobial prophylaxis within 48 hours
Other thoughts…

• Put systems in place to ensure non-antibiotic and antibiotic factors are followed
• Don’t forget about basics like hand hygiene, aseptic technique, disinfection and sterilization
• Minimize OR traffic and optimize air handling and room set up
• Proper hair removal, glucose control, smoking cessation, and skin preparation are important
• Maintenance of normothermia and level of administered oxygen (FIO2 80%) may be beneficial
Beneficial effects of oxygen therapy in wound healing and SSI

- Direct bacteriostatic and bactericidal effect on microorganisms, esp. anaerobes
- Enhancement of PMN function, phagocytosis, microbial killing
- Enhancement of tissue repair mechanisms-fibroblast proliferation, collagen deposition, migration of epithelial cells
Tissue oxygen delivery is key to native antimicrobial mechanisms

Affected by body temperature, circulating volume, $O_2$ content

Mauermann et al., Anesthesiology 2006 105:413-21
Randomized controlled trials examining supplemental O2 and SSI

- Myles et al., Anesthesiology 2007; 107:221-31
- Belda et al., JAMA 2005; 294: 2035-2042
- Pryor et al., JAMA 2004; 291: 79-87
Meta-Analysis of RCTs

Overall pooled odds ratio
0.742 (0.599-0.919)
p=0.06

Mayzler et al., 2005
Pryor et al., 2004
Belda et al., 2005
Greif et al., 2000
Myles et al., 2007
Summary

• Good preclinical and clinical data exist to support the use of perioperative hyperoxygenation therapy
• Pryor et al. study has engendered debate, but has several flaws

• Pros: inexpensive, simple, low risk
• Cons: unclear benefit in a generalized population
Conclusions

• SSI is a common, preventable, adverse event
• Antimicrobial prophylaxis is a critical prevention strategy
  – Right agent, right dose, right timing, right duration
  – Redosing
• A broad array of patient and procedural factors affect the risk of SSI
• A multi-factorial and multi-disciplinary approach is needed for SSI prevention