Preventing Surgical site Infections
Dr. Dick Zoutman, Queen’s University
A Webber Training Teleclass

Preventing Surgical Wound Infections:
A funny thing happens on the way to the OR

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Hosted by Paul Webber paul@webbertraining.com
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Practical Meaning of Quality

“80%” Good
– 36 million checks drawn on wrong account every day
– 9 million credit card transaction errors daily
– 1000 fold increase in aviation deaths

“99%” Good
– Unsafe drinking water 15 minutes each day
– No electricity for almost 7 hours each month

“99.9%” Good
– 16,000 lost articles of mail per hour
– 2 unsafe landings per day at most major airports

Medical Mishaps

![Diagram showing Medical Mishaps]

Burden of Nosocomial Infections

<table>
<thead>
<tr>
<th>Infection Type</th>
<th>Rate per 100 adm.</th>
<th>No. Infections per Year</th>
<th>Extra Days per Case</th>
<th>Extra Bed Days/yr</th>
<th>Cost per Infection</th>
<th>Cost per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical Wound</td>
<td>1.39</td>
<td>53,421</td>
<td>8.2</td>
<td>438,052</td>
<td>$4100</td>
<td>$219</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>0.60</td>
<td>23,060</td>
<td>20.0</td>
<td>461,200</td>
<td>$10,000</td>
<td>$230</td>
</tr>
<tr>
<td>Bacteremia</td>
<td>0.27</td>
<td>10,377</td>
<td>24.0</td>
<td>249,048</td>
<td>$12,000</td>
<td>$125</td>
</tr>
<tr>
<td>Urinary</td>
<td>2.39</td>
<td>91,853</td>
<td>2.4</td>
<td>220,447</td>
<td>$1,200</td>
<td>$110</td>
</tr>
<tr>
<td>Other</td>
<td>1.07</td>
<td>41,123</td>
<td>4.8</td>
<td>197,390</td>
<td>$2,400</td>
<td>$97</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>219,834</strong></td>
<td></td>
<td><strong>1,566,137</strong></td>
<td></td>
<td><strong>$781</strong></td>
</tr>
</tbody>
</table>


History of SSI Prevention and Control

• Before the mid-19th century
  Surgery = purulent drainage, sepsis and often death
  – 1843 Oliver Wendell Holmes - “dirty hands” paper
  – 1861 Ignaz Semmelweis - handwashing with chloride lime solutions
  – 1863 Louis Pasteur - germ theory
  – 1867 Joseph Lister - antiseptic principles

Surgical Wound Infections
Extra LOS

<table>
<thead>
<tr>
<th>Gross and Attributable Wound Infection Related Length of Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time Period</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Gross Infection LOS</td>
</tr>
<tr>
<td>Attributable Infection LOS</td>
</tr>
</tbody>
</table>

Zoutman et al Inf Contr Hosp Epi 1999

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Distribution of SSI Costs

Zoutman et al Inf Contr Hosp Epi 1999

SSI Risk Factors

• Patient Risk Factors
  – Age
  – Nutritional status
  – Diabetes
  – Smoking
  – Steroids
  – Pre-op LOS
  – *Colonization with S. aureus
  – Peri-op transfusions
  – Remote infection

• Operative Characteristics
  – *Pre-op antiseptic showers
  – Patient skin prep in the OR
  – Pre-op hand/arm antisepsis
  – Infected/colonized OR staff
  – *Antimicrobial prophylaxis

• Operative Characteristics (Cont’d)
  – *OR Ventilation
  – Environmental cleaning in the OR
  – Microbial sampling of the OR
  – *Sterilization of equipment
    • Flash sterilization
  – Scrub suits, masks, caps, boots
  – Gowns and drapes

• Operative Characteristics (Cont’d)
  – Asepsis in OR
  – Surgical technique
  – Drains
  – *Hypothermia <36°C
  – *Supplemental oxygen
  – Dressings
  – Discharge planning

Surgical Techniques & SSI Risk

• Maintaining effective hemostasis
• Preventing hypothermia
• Gently handling tissues
• Avoiding inadvertent entries into a hollow viscus
• Removing devitalized tissues
• Using drains and suture material appropriately
• Eradicating dead space
• Managing the postoperative incision

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Perioperative Complications following CABG
- Atrial fibrillation 19.4%
- Ventilation >1 day 5.5%
- Readmission within 30 days 5.2%
- Surgical site infection 2.6%
- Defirium 2.6%
- Pneumonia 2.5%
- Stroke 2.4%
- UTI 1.5%

Society of Thoracic Surgeons Database, 1999

SSI Rates* by Surgery Type and Risk Index Category

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Duration</th>
<th>Risk</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abd Hysterectomy</td>
<td>2 hr</td>
<td></td>
<td>1.5</td>
<td>2.5</td>
<td>6.1</td>
<td>**</td>
</tr>
<tr>
<td>Knee Prosthesis</td>
<td>2 hr</td>
<td></td>
<td>0.9</td>
<td>1.2</td>
<td>2.0</td>
<td>**</td>
</tr>
<tr>
<td>Small Bowel Surgery</td>
<td>3 hr</td>
<td></td>
<td>5.6</td>
<td>7.5</td>
<td>9.8</td>
<td>14.8</td>
</tr>
<tr>
<td>CABG (chest &amp; leg)</td>
<td>5 hr</td>
<td></td>
<td>0.7</td>
<td>3.5</td>
<td>5.8</td>
<td>17.5</td>
</tr>
</tbody>
</table>

* Infections per 100 procedures
** Risk index categories 2 & 3 combined
Source: NNIS Semiannual Report, June 1999

Surgical Wound Surveillance
- Of Proven Efficacy
- Risk Stratification
  - NNIS= 1 point for each of:
    - ASA Score>2
    - Wound class contaminated/dirty
    - Procedure duration > 75th %ile
- Case finding methods
- Post Discharge surveillance, day surgery
- Reporting Rates to surgeons

Supplemental Perioperative O2
- DESIGN: Randomized controlled trial, double blind
- POPULATION: Colorectal surgery (N=500)
- INTERVENTION: 30% vs 80% inspired oxygen during and up to 2 hours after surgery
- RESULTS: SSI incidence 5.2% (80% O2) vs 11.2% (30% O2), p=0.01

Antimicrobial Prophylaxis: 4 Principles

- Use AMP agent for operations where use reduced SSI rates or for operations where an SSI would be catastrophic
- Use AMP agent that is safe, inexpensive, and bactericidal for likely contaminants
- Time initial dose of AMP agent such that bactericidal concentration is in serum and tissues by time skin incised
- Maintain therapeutic levels during operation

Prophylaxis: Agents, Timing

- 1st and 2nd generation cephalosporins most commonly used AMP agents
- Administration of AMP agent ≤ 2 hours before incision reduced SSI risk (0.59% vs ≥ 3.3%)(Classen, 1992)
- General consensus: Administer AMP no more than 30 min before incision
  - Except CSEC, after cord clamping
  - Except vancomycin, about 1 hour before incision

Optimal Surgical Antimicrobial Prophylaxis

Includes 3 factors:
- Appropriate choice of antimicrobial agent
- Proper timing of administration of antimicrobial agent prior to surgical incision
- Limiting duration of antimicrobial administration following surgery

Impact of Timing of Antimicrobial Prophylaxis (AP)

- DESIGN: Prospective study
- POPULATION: Clean and clean contaminated procedures (N=2847)

Impact of Timing of AP on SSI Risk

<table>
<thead>
<tr>
<th>TIMING</th>
<th>SSI INCIDENCE</th>
<th>RR</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-24 hours preop</td>
<td>3.8%</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>&lt;2 hours preop</td>
<td>0.6%</td>
<td>0.15</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3 hours postop</td>
<td>1.4%</td>
<td>0.37</td>
<td>0.11</td>
</tr>
<tr>
<td>3-24 hours postop</td>
<td>3.3%</td>
<td>0.86</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Impact of Prolonged Surgical AP

- DESIGN: Prospective
- POPULATION: CABG patients (N=2641)
  - Group 1: pts who received ≤ 48 hrs of AP
  - Group 2: pts who received > 48 hrs of AP
- OUTCOMES:
  - Incidence of SSI
  - Isolation of a resistant pathogen

Impact of Prolonged Surgical AP

• RESULTS: 57% patients received AP \( \leq 48 \text{ hr} \)
  43% patients received AP \( >48 \text{ hr} \)

SSI Incidence
• \( \leq 48 \text{ hr group}: 8.7\% (131/1502) \) versus
• \( >48 \text{ hr group}: 8.8\% (100/1139), p=1.0 \)

Antimicrobial resistant pathogen
• OR 1.6 (95% CI 1.1-2.6)

• Pseudolus: Wait!
• Hero: Yes?
• Pseudolus: A brilliant idea!
  Hero: Yes!
• Pseudolus: That's what we need, a brilliant idea.
  • From: “A Funny Thing Happened On The Way To The Forum”
    – By Stephen Sondheim

The Study Setting

• Kingston General Hospital
• 466 tertiary care center
• Hospital based prospective cohort study
• Data collected between 1994 and 2000 (6 years)
• 7,388 patients entered into study
• 669 cases excluded
• 6,719 cases left to be analyzed

Surgical Wound Surveillance Methods

• Full Time Infection Control Practitioner
• Receives OR list each day
• Reviews chart and examines wound every 48-72 hours or more often if suspicious of infection
• CDC’s definition of wound infection used
• Details of prophylaxis and selected risk factors recorded
• Review of patient care computer system for readmits with infection
• Monthly reports to each surgeon/ICC

Inclusion/Exclusion Criteria

Included
• CABG
• Cardiac Valves
• Lung Resection
• AAA
• Lower Limb Vascular
• Colonic Resection
• Abdo-Hysterectomy
• Hip/Knee Replacement

Excluded
• Emergency procedures
• Wound class of 3 or 4
• Patients <18 years
• Patient with 2 or more procedures requiring >1 incisions during the same operation
• Patient on antibiotics 24 hour pre-op for infections or endocarditis prophylaxis
• Incomplete data in chart

Outcome Variables

• Effective First Prophylactic Dose (EFPD):
  – Correct Drug (guidelines)
  – Correct Dose (guidelines)
  – Correct Route
  – Correct Timing (within 120 minutes pre-op)
• Surgical Wound Infection
  – CDC 1996 criteria
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Hospital and Patient Variables

Hospital
- Where the FPD given (OR/floor)
- Same day surgery
- Time between FPD and incision
- Procedure Duration
- Net Duration of post-op SPA
- Calendar Year
- Class of Wound
- Order Written
- Effective First Prophylactic Dose

Patient
- Age
- Gender
- NNIS risk level
- Beta-lactam allergy
- Pre-op days
- Pre-op critical care days
- Procedure category
- IV drugs given the day before surgery

Surgical Prophylactic Antibiotic Protocol

<table>
<thead>
<tr>
<th>Procedure</th>
<th>1st Choice</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary artery bypass grafting or valve replacement</td>
<td>ceftazolin</td>
<td>vancomycin</td>
</tr>
<tr>
<td>Vascular surgery of abdominal aorta, groin vessels, or insertion of a prosthetic graft</td>
<td>ceftazolin</td>
<td>vancomycin</td>
</tr>
<tr>
<td>Total joint replacement</td>
<td>ceftazolin</td>
<td>vancomycin</td>
</tr>
<tr>
<td>Colorectal surgery</td>
<td>neomycin + erythromycin orally and/or metronidazole + gentamicin</td>
<td>neomycin + erythromycin orally and/or cefotiam</td>
</tr>
<tr>
<td>Thoracotomy for lung resection</td>
<td>ceftazolin</td>
<td>vancomycin</td>
</tr>
<tr>
<td>Hysterectomy, abdominal</td>
<td>ceftazolin</td>
<td>Dicyclline IV one dose or metronidazole + gentamicin</td>
</tr>
</tbody>
</table>

Analyses
- Univariate analysis:
  - Produce frequencies and rates
  - Assess distributions, normality, skewness
- Bivariate analysis:
  - Evaluation of associations (2 x 2 tables)
  - Unadjusted odds ratios
  - Stratified frequencies and rates
- Multivariate analysis:
  - Enter statistically significant variables into multiple logistic regression model
  - EFPD, SSI as outcomes

Effective First Prophylactic Dose Success Rate over 6 Years

Proportion of Same Day Surgical Cases over 6 Years

EFPD Component Errors

Note: 86% of “Not Given” were from gynaecology

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Risk Factors for SSI

<table>
<thead>
<tr>
<th>Effective First Procedure</th>
<th>NNIS Risk</th>
<th>Time of first Procedure</th>
<th>Prophylactic Dose Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prophylactic Dose Duration</td>
<td>Index</td>
<td>Prophylactic dose</td>
<td>0.69</td>
</tr>
<tr>
<td>1.4 (100-139)*</td>
<td>1.9 (1)</td>
<td>1.3 (&gt;2h early)*</td>
<td>1.4 (Cardiothoracic)*</td>
</tr>
<tr>
<td>2.0 (140-199)</td>
<td>1.4 (2)*</td>
<td>1.4 (Post-Incision)*</td>
<td>10.1 (Colonic)</td>
</tr>
<tr>
<td>3.6 (≥ 200)</td>
<td>2.8 (Not given)</td>
<td>2.9 (Gynaecologic)</td>
<td></td>
</tr>
</tbody>
</table>

R= Reference Group *= Not significant (p>.05)

Summary of Factors Predicting for EFPD

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Order Written</th>
<th>SPA Given in OR</th>
<th>β lactam allergy</th>
<th>Same Day Admit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiothoracic</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Vascular</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Colonic</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Hysterectomy</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Joint Replacement</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
</tbody>
</table>

Results: Adjusted predictors of an SSI

- EFPD: OR= 0.63 (p= 0.005)
- Procedure Duration over 200 minutes: OR= 3 (p< 0.001)
- NNIS Risk score of 1 OR= 2 (p< 0.004)
- Time of first dose relative to incision: For those that were given none, OR=2.9 (p=0.002)
- Procedure category (when compared to orthopaedics):
  - Colonic OR=11.1 (p< 0.001)
  - Vascular OR= 3.6 (p< 0.001)
  - Gynaecologic OR= 2.6 (p = 0.005)

Interventions

- Improving Awareness
  - Feedback EFPD rates to surgeons, OR Staff
- Analysis of workflow
  - Preop assessment of “allergies”
  - Start IV’s in one location preoperatively
  - OR stock of approved antibiotics
- Responsibility to write the order for SPA
  - Anesthesiology vs surgery

Application

- Results only applicable to KGH
- Determined patient and process variables detrimental and beneficial to administering an EFPD
- Using focal points can devise intervention
  - Educational materials
  - Feedback of practice info to physicians
  - Physical structure of administering environment

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Cardiac Surgery, 1999-2001
Number of Procedures By CHEC Site

Cardiac Surgery, 1999-2001
Number of Procedures By Age Group

Cardiac Surgery, 1999-2001
Number of Procedures By Age For Infants

Cardiac Surgery, 1999-2001
Number of Procedures By Gender

Cardiac Surgery, 1999-2001
Number of Procedures By Class *

Cardiac Surgery, 1999-2001
Infection Rate By Depth *

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Cardiac Surgery, 1999-2001
Infection Rates By Depth

- Adults
  - No Infection: 95.5%
  - Superficial: 3.4%
  - Deep: 0.4%
  - Organ Space: 0.6%
- Peds
  - No Infection: 95.5%
  - Superficial: 2.9%
  - Deep: 1.0%

I sure hope he remembers my antibiotic

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- **February 15** – Endemic Influenza, Pandemic Influenza, and Avian Flu
  with Dr. Stephano Lazzari
- **February 17** – Sad Cows and Englishmen, Predicaments and Predictions for Spongiform Encephalopathies
  with Dr. Corrie Brown
- **February 24** – Sneezes, Coughs and Drips: Respiratory and GI Outbreaks in Long Term Care
  with Dr. Chesley Richards
- **March 10** – Biocide Use in a Healthcare Environment
  with Dr. Jean-Yves Mailard
  with Dr. Didier Pittet

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