PERIOPERATIVE ANTIBIOTIC PROPHYLAXIS AND SURGICAL SITE INFECTION

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University of Kentucky
You ain’t gonna learn what you don’t want to know.

Grateful Dead
Department of Surgery 1964

- Ben Eiseman - Chairman
  - Frank C. Spencer
  - Benjamin Rush
  - Rene Menguy
  - Ward O. Griffen
  - Tom Brower
EXCESSALBE
HANDYCAP
RESTROOMS
Kentucky Dialect

- Versailles
- Vursales
- Athens
- Aythens
- Louisville
- Looavul
- Irvine
- Ervun
- Liketakillme
- Hurts like hell!
- Aherdat!

Affirmation or Agreement
“Survival of the fittest”

Herbert Spencer
Antibiotics and Resistance

- Close association between use of antibiotics and emergence of resistant pathogens
- Prior antibiotic exposure coupled with several other risk factors
  - Prolonged LOS
  - Presence of invasive devices

Kollef MH. Clin Infect Dis. 2000;31:S131-8
Factors Increasing Antibiotic Resistance

- Increased severity of illness
- More severely immunocompromised patients
- Newer devices and procedures
- Resistance in the community
- Ineffective infection control and compliance
- Increased prophylactic, empiric antibiotics
- Higher antibiotic use per area per unit time
Epidemiology

- 18 million surgical procedures yearly
  - 486,000 nosocomial infections
    - 20% in intensive care unit, with SICU highest risk
- Patients have longer and costlier hospitalization
  - Twice as likely to die
    - Mortality rate up to 44% in ICU patients
  - 60% more likely to spend time in ICU
  - Five times more likely to be re-admitted
  - Excess direct cost $5,038/infected patient

Emerging Pathogen

What is an emerging pathogen?
EMERGING INFECTIOUS DISEASES: DEFINITION

New, reemerging or drug-resistant infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future
What are the “Emerging Pathogens”?

- Multi-Drug Resistant Gram Negative Bacilli
  - ESBLs (*E. coli*, *Klebsiella*)
  - *P. aeruginosa*
  - *Acinetobacter* spp.
- Vancomycin-Resistant Enterococci
  - *Enterococcus faecium*
- Methicillin-Resistant *S. aureus*
- *Clostridium difficile*-Associated Disease
Consequences of Overuse of Cephalosporins

Third-Generation Cephalosporins

Overuse

- Klebsiella sp
- Eschericia coli with ESBLS*

- AmpC Enterobacter

- Enterococcus sp

Resistance

- Imipenem/cilistatin

Selection

- Pseudomonas sp
- Acinetobacter sp

- Fungi
- Yeast

- Vancomycin

No coverage

VRE**

*Extended Spectrum Beta-Lactamases  ** Vancomycin Resistant Enterococci
Question 1
Which IV Antibiotic(s) Would You Choose for Prophylaxis of Elective Colon Surgery?

A. Ampicillin/sulbactam
B. Cefazolin
C. Cefoxitin
D. Ceftriaxone and metronidazole
E. Gentamicin and metronidazole
Question 1
Which IV Antibiotic(s) Would You Choose for Prophylaxis of Elective Colon Surgery?

A. Ampicillin/sulbactam
B. Cefazolin
C. Cefoxitin
D. Ceftriaxone and metronidazole
E. Gentamicin and metronidazole
Question 2
When Would You Administer The First Dose of Antibiotic(s)?

A. At 10:30 AM
B. “On call” to the OR
C. In the preoperative holding area
D. Upon induction of anesthesia
E. At the time of skin incision
Question 2
When Would You Administer The First Dose of Antibiotic(s)?

A. At 10:30 AM
B. “On call” to the OR
C. In the preoperative holding area
D. Upon induction of anesthesia
E. At the time of skin incision
Question 3
When would you give the next dose of antibiotic(s)?

A. At 4-hour point
B. At 6-hour point
C. In Recovery Room
D. None needed
Question 3
When would you give the next dose of antibiotic(s)?

A. At 4-hour point
B. At 6-hour point
C. In Recovery Room
D. None needed
Major Pathogens in Surgical Wound Infection

- S. aureus: 20%
- CNS: 18%
- Enterococci: 14%
- E. coli: 12%
- P. aeruginosa: 10%
- Enterobacter spp.: 8%
Appropriate Prophylactic AB
↓ infections
↓ mortality
↓ costs

Inappropriate Prophylactic AB
↑ adverse events
↑ likelihood resistant pathogens
↑ resistance globally
Appropriate Antibiotic Prophylaxis

- Shortest duration of antibiotics with equivalent efficacy
- Dosing at correct time interval
- Narrowest spectrum with equivalent efficacy
- Use of an antibiotic with good safety profile
Appropriate Antibiotic Prophylaxis

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- Use of an antibiotic with good safety profile
Duration of Therapy

- Period: 10/1/95 and 4/30/97
- Data from charts collected and retrospectively reviewed
- End points of study:
  - Frequency prophylaxis continued >24 h
  - Cost of prophylaxis given >1 d
  - Frequency of line infections and bacteremias in patients receiving <1 d vs. >4 days of prophylaxis

# Effect of Duration on Infections

<table>
<thead>
<tr>
<th></th>
<th>All patients</th>
<th>Nontransplant patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration of prophylaxis</strong></td>
<td>&lt;1 day</td>
<td>&gt;4 days</td>
</tr>
<tr>
<td>No. of patients</td>
<td>180</td>
<td>94</td>
</tr>
<tr>
<td>No. of patients developing bacteremia (%)</td>
<td>6 (3%)</td>
<td>16 (17%)</td>
</tr>
<tr>
<td></td>
<td>P&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>No. of line infections (%)</td>
<td>4 (2%)</td>
<td>14 (15%)</td>
</tr>
<tr>
<td></td>
<td>P&lt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>

Appropriate Antibiotic Prophylaxis

• Shortest duration of antibiotics with equivalent efficacy

• Dosing at correct time interval

• Narrowest spectrum with equivalent efficacy

• Use of an antibiotic with good safety profile
Timing and Risk of Wound Infection

• Prospective study
  – 2847 patients
  – Elective clean or “clean-contaminated” surgery
  – Timing of prophylaxis
    • **Early** - 2 to 24 hrs pre-operatively
    • **Preoperatively** - ≤2 h before the incision
    • **Perioperative** - ≤3 h after incision
    • **Postoperative** - >3 and <24 h after incision

Relation Between Timing and Surgical Wound Rate

Timeliness of Antibiotic Prophylaxis

- Retrospective review of charts
  - Abdominal aortic aneurysm repair
  - Partial or total hip replacement
  - Large bowel resection

- 44 teaching hospitals in New York State
  - 2256 Medicare patients
  - 395 Medicaid patients

Timeliness of Antibiotic Prophylaxis

- 44 different Abx utilized
- 14% received no antibiotics
- 37% of those Rx’ed received at inappropriate time
- Recommend delegating prophylaxis to anesthesia team

UNIVERSITY OF KENTUCKY HOSPITAL
Cardiovascular Surgery
Pre-op Antibiotic Usage
July 2000 - September 2001

- No PAB: 6%
- After Incision: 6%
- Given/No Time Documented: 13%
- < 30 Min: 15%
- 31 - 1 Hr: 23%
- >1 Hr < 2 Hr: 20%
- >2 Hr: 17%
Timing of Administration

Prophylactic antibiotics
  – Induction of anesthesia

Re-dose antibiotics if
  – procedures > 4 hrs
  – major blood loss during procedure
Appropriate Antibiotic Prophylaxis

- Shortest duration of antibiotics with equivalent efficacy
- Dosing at correct time interval
- Narrowest spectrum with equivalent efficacy
- Use of an antibiotic with good safety profile
EMERGENCE OF MRSA

Organisms Isolated from Infectious Foci

% Rate of Resistance

1982-84 1985-87 1988-90

TYPES OF PROPHYLAXIS PROVIDED OVER TIME

Rates of Cephalosporin Usage

* P<0.01 vs. Index Period (1982-1984)

Results of Interventions

Organisms Isolated from Infectious Foci

- MSSA
- MRSA
- Enterococcus
- E. coli
- Fungi

RESULTS

• Overuse of 3\textsuperscript{rd}-generation cephalosporins for extended periods caused an MRSA outbreak
• Long-term prophylaxis did not lower infection rates
• MRSA rates decreased as usage of third-generation cephalosporins declined
• Prophylaxis with first- or second-generation cephalosporins should be as brief as possible

Appropriate Antibiotic Prophylaxis

- Shortest duration of antibiotics with equivalent efficacy
- Dosing at correct time interval
- Narrowest spectrum with equivalent efficacy
- Use of an antibiotic with good safety profile
Safety Issues

Antibiotic use and adverse drug events (ADEs)

- 4031 tertiary care center admissions for ADEs and potential ADEs
- Antibiotics second most common drug class for ADEs
- ADEs in 24% of those receiving antibiotics

Bates DW, et al *JAMA* 1995; 274: 29-34
INDICATIONS FOR ANTIBIOTICS

Potential Role of Prophylaxis

**Clostridium difficile** Colonization Following a Single Dose

(N=103)

<table>
<thead>
<tr>
<th>Medication</th>
<th>Colonization at 14 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cephalosporins</td>
<td>23</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>14.3</td>
</tr>
<tr>
<td>Cefoxitin</td>
<td>8.3</td>
</tr>
<tr>
<td>Cefotetan</td>
<td>20</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>25</td>
</tr>
<tr>
<td>Cefoperazone</td>
<td>43.7</td>
</tr>
<tr>
<td>Mezlocillin</td>
<td>3.3</td>
</tr>
<tr>
<td>Control (none)</td>
<td>0</td>
</tr>
</tbody>
</table>

RESULTS

• Most frequent indicators of CDAD
  – Abdominal pain
  – Distention
  – Nausea
  – Fever

• White blood cells and presence or absence of blood in stool did not contribute to diagnosis

INCIDENCE OF CDAD

RESULTS

- Strong positive correlation with 3rd-generation cephalosporins
- Strong negative correlation for ticarcillin/clavulanate, aminoglycosides, and metronidazole
- Increased association with IV vancomycin but not statistically
- No correlation for 1st- or 2nd-generation cephalosporins or erythromycin

Antibiotic Utilization in Surgical Patients with *C. difficile*-associated Diarrhea

- Ciprofloxacin and cefoxitin most common antibiotics prescribed before diagnosis
- Patients with *C. difficile* had higher mortality compared with control
  - (31% vs. 11% (p = 0.01))
- Time from completion of antibiotic course to diagnosis was 7 +/- 2 days
- 16% developed diarrhea after prophylactic antibiotics

PROBLEM

• CDAD currently principal cause of diarrhea in the hospital
• Incidence of CDAD increasing
• Broad-spectrum antibiotics alter normal aerobic/anaerobic balance
  – Reduced “colonization resistance”
• Third-generation cephalosporins implicated
  – Cefotaxime
  – Ceftriaxone

RESULTS

## ASSOCIATION OF SELECTED ANTIMICROBIAL WITH CDAD

<table>
<thead>
<tr>
<th>Agent</th>
<th>Association with CDAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clindamycin</td>
<td>++</td>
</tr>
<tr>
<td>2nd- and 3rd-Generation Cephalsporins</td>
<td>++</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>++</td>
</tr>
<tr>
<td>Amp/sulbactam</td>
<td>+</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>+</td>
</tr>
<tr>
<td>Pip/tazo</td>
<td>-</td>
</tr>
<tr>
<td>Ticar/clav</td>
<td>-</td>
</tr>
</tbody>
</table>

++ Common   + Uncommon   - Rare
When Should Antibiotic Prophylaxis Be Used?

• Surgical procedures with a high rate of wound infections
  – clean-contaminated, contaminated
• Implantation of prosthetic materials
• Surgical procedures where infection would have severe consequences
# Traditional Classification of Operative Procedures and Risk of Infection

<table>
<thead>
<tr>
<th>Type of Procedure</th>
<th>Risk of SSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>&lt; 2 %</td>
</tr>
<tr>
<td>Clean-Contaminated</td>
<td>5 - 15 %</td>
</tr>
<tr>
<td>Contaminated</td>
<td>15 - 30 %</td>
</tr>
<tr>
<td>Dirty*</td>
<td>&gt;30%</td>
</tr>
</tbody>
</table>

*Dirty wounds ≈ infection - antibiotics indicated as therapy*

Medical Conditions Known to Increase Risk of Surgical Site Infection

- extremes of age
- undernutrition
- obesity
- diabetes
- prior site irradiation
- hypoxemia
- remote infection
- corticosteroid therapy
- recent operation
- chronic inflammation

Antibiotic prophylaxis may be indicated in clean cases when associated conditions increase infection risk.
## NNIS Risk Index as a Predictor of Risk of Infection

<table>
<thead>
<tr>
<th>Traditional Class</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>1.0%</td>
<td>2.3%</td>
<td>5.4%</td>
<td>NA</td>
<td>2.1%</td>
</tr>
<tr>
<td>Clean/Contam</td>
<td>2.1%</td>
<td>4.0%</td>
<td>9.5%</td>
<td>NA</td>
<td>3.3%</td>
</tr>
<tr>
<td>Contaminated</td>
<td>NA</td>
<td>3.4%</td>
<td>6.6%</td>
<td>13.2%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Dirty</td>
<td>NA</td>
<td>3.1%</td>
<td>8.1%</td>
<td>12.8%</td>
<td>7.1%</td>
</tr>
<tr>
<td>All</td>
<td>1.5%</td>
<td>2.9%</td>
<td>6.8%</td>
<td>13.0%</td>
<td>2.8%</td>
</tr>
</tbody>
</table>

Nichols RL, Martone WJ. *Surgery* 2000; 128: S2-S13
Technical Factors May Outweigh Benefit

- Fluid/blood collections
- Ischemia/poor blood supply
- Inoculum
Clean Surgical Procedures

- Most do not require antibiotics
- Indicated in:
  - Prosthetic materials
  - Cardiothoracic, vascular procedures
  - Possibly breast and hernia
- Likely pathogens:
  - Above waist
    - Gram positive aerobic coverage - cefazolin
  - Below waist
    - Gram positive and Gram negative enterics - cefazolin

Clean Surgical Procedures

Special Circumstances

• Increased risk of MRSA
  – known colonization with MRSA
  – hospital MRSA infection rate at > 50%
  – ?chronic dialysis, chronic diabetic foot ulcers

• Vancomycin alone - above the waist
• Vancomycin alone - below waist
Clean Contaminated/Contaminated Procedures

Head and Neck
- cefazolin ± metronidazole
- clindamycin ± gentamicin

Gastroduodenal
- cefazolin - high risk only

Biliary tract
- cefazolin - high risk only
- ?2GC or Amp/sul
- laparoscopic - none

Appendectomy (non-perf)
- Ampicillin/sulbactam

Colorectal
- oral prep
  - neomycin + eryth.
- Ampicillin/sulbactam
  - ± combination in high risk

Gynecologic
- cefazolin or Ampicillin/sulbactam
Appropriate Duration of Therapy

- Single dose therapy is as effective as multiple doses in majority of studies
  - Longer therapy indicated in some cases
    - usually related to inadequate data
  - No studies indicate prophylaxis longer than 72 hrs is beneficial
  - No studies support continuing therapy for drains/tubes
Appropriate Duration of Therapy

Neurosurgical

• Recommendation: single dose
  – meta-analysis found no difference in single vs multiple dose regimens

Head and Neck

• Recommendation: ≤ 24 hours
  – single dose/< 24 hours not studied

Am J Health Syst Pharm 1999; 56:1839-88
Appropriate Duration of Therapy

Cardiothoracic

• Recommendation: < 72 hours
  – studies demonstrate no difference in single, short, or longer courses of therapy.
  – **No evidence** to support continued coverage of mediastinal drains

Gastroduodenal

• Recommendation: single dose
  – 2 studies demonstrate equal efficacy with multiple dose

*Am J Health Syst Pharm 1999; 56:1839-88*
Appropriate Duration of Therapy

Hepatobiliary
- Recommendation: single dose
  - multiple studies demonstrate equal efficacy with single and multiple dose

Appendectomy
- Recommendation: single dose
  - studies with single dose or multiple dose regimens demonstrate similar infection rates

Colorectal
- Recommendation: single dose
  - multiple studies single vs multiple dose, only 2 with same regimen - no difference in infection rates
Appropriate Duration of Therapy

Vascular
- Recommendation: 24 hours
  - inadequate studies examining < 24 hours

Solid Organ Transplant
- Insufficient studies for heart and liver
- Recommendations:
  - Heart: 48 - 72 hours
  - Liver: 48 hours
  - Kidney: single dose

Am J Health Syst Pharm 1999; 56:1839-88
Prophylactic Antibiotics
Appropriate Choice

- Narrowest spectrum to cover likely pathogens
- Avoid agents that are therapeutic choices
  - 3rd/4th generation cephalosporins and new agents should not be used
- Agents with moderately long half-life
- Good safety profile
<table>
<thead>
<tr>
<th>Surgical Category</th>
<th>Antimicrobial Agent and Adult Dose</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular and Non-Cardiac Thoracic</td>
<td>Cefazolin 1gm IV x 1</td>
<td>24 hours or less</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Amoxicillin/Sulbactam 3gms IV x 1</td>
<td>Pen Allergy:</td>
</tr>
<tr>
<td>Biliary, Gastroduodenal, Appendix (non-perf), Colorectal</td>
<td></td>
<td>Clindamycin 900mg IV x 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gentamicin 5mg/kg IV x 1</td>
</tr>
<tr>
<td>Orthopedic</td>
<td>Cefazolin 1gm IV x 1</td>
<td>Most clean cases without prosthetic do not require prophylaxis</td>
</tr>
<tr>
<td>With prosthetic Material</td>
<td>Most clean cases without prosthetic do not require prophylaxis</td>
<td></td>
</tr>
<tr>
<td>Head and Neck</td>
<td>Cefazolin 1gm IV x 1</td>
<td>Most clean cases without prosthetic do not require prophylaxis</td>
</tr>
<tr>
<td>With prosthetic Material</td>
<td>Most clean cases without prosthetic do not require prophylaxis</td>
<td></td>
</tr>
<tr>
<td>Head and Neck</td>
<td>Cefazolin 1gm IV x 1</td>
<td>Cephalosporin or Pen Allergy:</td>
</tr>
<tr>
<td>Clean-Contaminated</td>
<td>Metronidazole 500mg IV x 1</td>
<td>Clindamycin 900mg IV x 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gentamicin 5mg/kg IV x 1</td>
</tr>
<tr>
<td>Surgical Category</td>
<td>Antimicrobial Agent and Adult Dose</td>
<td>Notes</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Neurosurgical</td>
<td>Cefazolin 1gm IV x 1</td>
<td></td>
</tr>
<tr>
<td>OB/GYN</td>
<td>Cefazolin 1gm IV x 1 or Amp/Sulb 3gms IV x 1</td>
<td>Antimicrobial should be administered after clamping umbilical cord</td>
</tr>
<tr>
<td>OB/GYN</td>
<td>Cefazolin 1gm IV x 1</td>
<td></td>
</tr>
<tr>
<td>Urologic</td>
<td>Sulfamthoxazole/Trimethoprim 160mg (TMP component) IV x1</td>
<td>Alternative agents may be necessary based on results of prior urine cultures. Doxycycline 100mg IV x1 may be given for patients with a sulfa allergy.</td>
</tr>
<tr>
<td>Hysterectomy</td>
<td>Cefazolin 1gm IV x 1</td>
<td></td>
</tr>
</tbody>
</table>
Perioperative Antibiotic Prophylaxis Protocol

**Notes:**

- For patients with known colonization with MRSA or previous MRSA infection, vancomycin 1gm IV x1 may be used for prophylaxis. *Vancomycin must be given over 60 minutes to minimize the likelihood of Red Man’s Syndrome.*

- For patients with cephalosporin allergies, or anaphylactic or other life-threatening allergies to penicillin agents, clindamycin 900mg IV x1 should be used.

- For patients weighing >100kg, cefazolin 2gm IV x1 should be used as an alternative to cefazolin 1gm IV x1.

- For all procedures in which cefazolin is administered, a repeat dose should be given if the procedure lasts >4 hours.
# Perioperative Antibiotic Prophylaxis Protocol

## Pediatric Dosing

<table>
<thead>
<tr>
<th>Antimicrobial Agent</th>
<th>Pediatric Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin</td>
<td>30mg/kg IV</td>
</tr>
<tr>
<td>Ampicillin/Sulbactam</td>
<td>50mg/kg IV (based on ampicillin component)</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>10mg/kg IV</td>
</tr>
<tr>
<td>Sulfamethoxazole/Trimethoprim</td>
<td>10mg/kg IV (based on trimethoprim component)</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>15mg/kg IV</td>
</tr>
<tr>
<td>Doxycycline</td>
<td>Not recommended for pediatric patients</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>3mg/kg IV</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>15mg/kg IV (must be given over 60 minutes)</td>
</tr>
</tbody>
</table>
PERIOPERATIVE ANTIBIOTIC PROPHYLAXIS

§ GOAL: To reduce SSI

†COMMON PATHOGENS:

‡Clean Surgical procedure (Risk <2%)
Most do not require antibiotics

Dirty Procedure (Risk >30%)
Infection present: Antibiotic indicated as therapy

Clean-Contaminated (Risk 5-15%)
Contaminated (Risk 15-30%)

Cefazolin ± Metronidazole or Clindamycin + Gentamicin
Duration <24 hrs

Antibiotic indicated
1. Implantation of prosthetic materials
2. Cardiovascular procedures
3. Vascular procedures
4. Neurosurgical Procedures
5. Possibly breast and hernia

Recommended antibiotics
- Cefazolin
  * Clindamycin/Erythromycin

Duration: Cardiovascular: <72 hrs
Vascular <24 hours
Others: ¥ Single dose

*Penicillin/Cephalosporin allergic patients. ¥ Redose if procedure lasts longer than 4 hrs.
†Consider using vancomycin in pts colonized with MRSA/MRSE
§ Antibiotics should be giving within one hr of procedure (During induction of anesthesia)
‡Duration of antibiotic prophylaxis for solid organ txp: Heart/Lung 48-72 hrs; Liver 48 hrs kidney single dose.
Surgical Site Infection

- Perioperative hygiene
- Skin preparation
- Hair removal
- Remote site infection

- Catheterization
- Irrigation
- Oxygen Tension
- Temperature
- Glucose control
- OR traffic
Perioperative Hygiene

- Shower with antiseptic soap the evening before and morning of elective surgery.
- Educate patients about their responsibility in preventing surgical site infection.
Skin preparation

• Chlorhexidine-based products are superior to iodine-based products for the prevention of surgical site infection.
• Chlorhexidine-based soaps are superior to iodine-based soaps for hand scrub.
  – Waterless scrubs are as good or better than water-based products.
Hair removal

- Hair removal should be performed immediately before the operative intervention.
- Clipping is superior to shaving
- Depilatory agents are effective but difficult to use.
Remote site infection

- Increased surgical site infection rate.
- Elective operative interventions should be rescheduled after treatment of the remote site infection.
Bladder catheter

- Increased infection rate for clean cases
  - Hernia repair
  - Total joint replacement

- Avoid catheterization
  - Void immediately before intervention
  - Limit intraoperative fluid administration
Irrigation of the Incision

- Meta-analysis of 7 studies
- No advantage to saline lavage
- No advantage to antibiotic lavage if the patient is receiving systemic antibiotics

Activities in excess of the removal of gross contamination using minimal volumes of a warm crystalloid solution are rituals that are devoid of biologic advantage.

Pressure Irrigation of the Incision After Appendectomy

- Randomized controlled trial of 350 patients
- A total of 283 patients (81%) had appendicitis
  - 34% had complicated appendicitis
- Randomization scheme
  - Group I (control): antibiotics alone
  - Group II (experimental): antibiotics plus pressure irrigation of incision (300 mL saline, 20-mL syringe, 19 gauge catheter)
- SSI rate decreased in complicated cases
  - 72.5% in group I vs. 16.3% in group II ($P = 0.000001$)

Perioperative Supplemental Oxygen and the Risk of SSI

- 500 patients undergoing colorectal resection
- Standardized anesthesia and antibiotics
- 30% vs. 80% inspired O₂
  - During surgery and first 2 hours of recovery
- SSI suspected if culture-positive drainage of pus
- 80% oxygen group had less infections
  - 5.2% vs. 11.2% (30% O₂ group) (P=0.01)

Perioperative Hypothermia and the Risk of SSI

- 200 patients undergoing colorectal surgery
- Standardized anesthesia and antibiotics
- Randomized to routine care (hypothermia, 34.7°C) or additional warming (normothermia, 36.6°C)
- SSI suspected if culture-positive drainage of pus
- Hypothermia group
  - More infections (18 vs. 6 in the normothermia group, \( P<0.01 \))
  - Longer hospitalization (2.6 days, \( P<0.01 \))

Early Postoperative Glucose Control Predicts Nosocomial Infection Rate in Diabetic Patients

- 100 initially uninfected diabetic patients undergoing elective surgery
- All patients received antibiotic prophylaxis
- Good glucose control, $\leq 220 \text{ mg/dL}$
- Poor glucose control and infection
  - All infections: RR 2.7 (31.3% vs. 11.5%)
  - Non-UTI infections: RR 5.9

RR, relative risk.

Glucose Control and SSI
Cardiac Surgery

- 1,000 consecutive patients
- 3% developed SSIs

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>2.76</td>
</tr>
<tr>
<td>Postoperative hyperglycemia</td>
<td>2.02</td>
</tr>
</tbody>
</table>

*Chronic poor glycemic control was not a risk factor*

Prevention of Surgical-Site Infection

• Preoperative
  – Preparation of patient
  – Hand/forearm antisepsis for surgical team
  – Management of infected or colonized surgical personnel
  – Antimicrobial prophylaxis

Prevention of Surgical-Site Infection

- **Intraoperative**
  - Ventilation
  - Cleaning and disinfection of environmental surfaces
  - Microbiologic sampling
  - Sterilization of surgical instruments
  - Surgical attire and drapes
  - Asepsis and surgical technique

- **Postoperative incision care**

- **Surveillance**

Half this game is 90% mental.

Yogi Bera
Good judgment comes from experience but experience only comes from bad judgment.