Infection Prevention after Surgery for EOS... Where Are We in 2014?

2014 ICEOS
Warsaw, Poland

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Disclosures

- No relevant financial disclosures related to this talk

- Based on pediatric literature

..........For the most part
Outline

• **What is the problem?**
  – Infection rate, benchmarks, $$, current practice

• **What do we know?**
  – What are the risk factors?
  – What reduces infection risk?

• **Where are we going?**
  – Is there a consensus?

• **Treatment**
The Problem

- Mean hospital charges:
  - $154,537 ($26,977-$961,722)

- Indirect costs:
  - Missed work, school, psychological

- Pay for performance

- Bundled care
What is the Infection Rate?
Infection Rate

- **AIS:**
  - 0.5-6.7%
- **Neuromuscular:**
  - 4.3-14.3%
- **Myelodysplasia:**
  - 6.1-30%

What’s the Evidence? Systematic Literature Review of Risk Factors and Preventive Strategies for Surgical Site Infection Following Pediatric Spine Surgery

Michael P. Glotzbach, MD, Matthew D. Riedel, BA, Michael G. Vitale, MD, MPH, Hiroko Matsumoto, MA, David P. Roye, MD, Mark Erickson, MD, John M. Flynn, MD, and Lisa Staiman, MD, MPH

*J Pediatr Orthop 2013;33:479–487*
Infection Rate

- **AIS:**
  - 0.5-6.7%

- **Neuromuscular:**
  - 4.3-14.3%

- **Myelodysplasia:**
  - 6.1-30%

- Repetitive procedures in patients with poor nutrition and medical comorbidities
# What is Infection Rate?

## VEPTR (10-32%)
- **Emans Spine 2005:** 3/31 (10%)
- **Campbell JBJS 2004:** 3/27 (11%)
- **Smith et al Spine Deformity 2011:** 16/97 (16%)
- **Garg Spine 2014:** 38/213 (18%)
- **Sankar Spine 2010:** 6/19 (32%)

## Growing Rods (7-40%)
- **Klemme JPO 1997:** 5/67 (7%)
- **Akbarnia Spine 2005:** 2/23 (9%)
- **Yang Spine 2011:** 5/49 (10%)
- **Kabirian JBJS 2014:** 42/379 (11%)
- **Bess JBJS 2010:** 15/140 (14%)
- **McElroy Spine 2011:** 11/80 (14%)
- **Sankar Spine 2010:** 4/10 (40%)
What is Infection Rate for Growing Rods?

- 379 patients
- 2344 procedures
- Min 2 year follow up

42 patients developed infection (11.1%)
  - 10 (2.6%) before first lengthening
  - 29 (7.7%) during lengthening
  - 3 after final fusion

Deep Surgical Site Infection Following 2344 Growing-Rod Procedures for Early-Onset Scoliosis

Risk Factors and Clinical Consequences

Nima Kabirian, MD, Behrooz A. Akharnia, MD, Jeff B. Pawelek, BS, Milad Alam, MD, Gregory M. Mundis Jr., MD, Ricardo Acacio, MD, George H. Thompson, MD, David S. Marks, FRCS, FRCS(Ortho), Adrian Gardner, MRCS, FRCS(Tr&Ortho),
Paul D. Sormellier, MD, MBA, David L. Skaggs, MD, MMM, and the Growing Spine Study Group

What is Infection Rate In VEPTR?

- **Unpublished Data:**
- **Overall Infection Rate:**
  - 18% (38 of 213)
- **55 total infection events**
  (1497 total procedures)

- 37% increase in odds each time incision opened
What is Infection Rate In VEPTR?

- By site: 2.9% to 42.9% (p=0.029)
Outline

• **What is the problem?**
  – Infection rate, benchmarks, $$, current practice

• **What do we know?**
  – What are the risk factors?
  – What reduces infection risk?

• **Where are we going?**
  – Is there a consensus?

• **Treatment**
What do we know?
What Do We Know?
Microbiology

- **Staphylococcus aureus (25%)**
  - MRSA (10.7%)
- **Coag neg Staphylococcus (17%)**
- Pseudomonas
- P. acnes (late)
- 47% polymicrobial (Gram neg)

### Table 2. Infecting Pathogen

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Patients (n = 53)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulase negative <em>Staphylococcus</em></td>
<td>47% (25)</td>
</tr>
<tr>
<td><em>S. aureus</em></td>
<td>17% (9)</td>
</tr>
<tr>
<td>Polymicrobial</td>
<td>15% (8)</td>
</tr>
<tr>
<td><em>Enterococcus</em></td>
<td>6% (3)</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>6% (3)</td>
</tr>
<tr>
<td>No growth</td>
<td>6% (3)</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>4% (2)</td>
</tr>
<tr>
<td>Enterobacter</td>
<td>4% (2)</td>
</tr>
<tr>
<td>Peptostreptococcus</td>
<td>4% (2)</td>
</tr>
</tbody>
</table>
**What Do We Know?**

**Microbiology**

Kabirian et al, Smith et al, Garg et al

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### TABLE III: Microorganisms Detected at the Initial Infection and Subsequent Recurrences

<table>
<thead>
<tr>
<th>Infecting Organism</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSSA</td>
<td>25</td>
</tr>
<tr>
<td>MRSA</td>
<td>9</td>
</tr>
<tr>
<td>Escherichia Coli</td>
<td>5</td>
</tr>
<tr>
<td>Enterococcus spp.</td>
<td>3</td>
</tr>
<tr>
<td>No Growth</td>
<td>3</td>
</tr>
<tr>
<td>Coag Neg Staph</td>
<td>2</td>
</tr>
<tr>
<td>Streptococcus spp.</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
<tr>
<td>Bacillus spp.</td>
<td>1</td>
</tr>
<tr>
<td>Stenotrophomonas maltophilia</td>
<td>1</td>
</tr>
<tr>
<td>Staphylococcus Warneri</td>
<td>1</td>
</tr>
<tr>
<td>Klebsiella oxytoca</td>
<td>1</td>
</tr>
<tr>
<td>Candida Albicans</td>
<td>1</td>
</tr>
<tr>
<td><em>Staphylococcus epidermidis</em></td>
<td>1</td>
</tr>
</tbody>
</table>

---

**TABLE 1:** Organisms Identified and Associated With VEPTR Infection

<table>
<thead>
<tr>
<th>Organism</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>15</td>
</tr>
<tr>
<td><em>Propionibacterium acnes</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Gram + cocci</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Staphylococcus epidermidis</em></td>
<td>1</td>
</tr>
</tbody>
</table>

---
What Do We Know?
Risk Factors

• **Patient Related**
  - Diagnosis, ASA, obesity, malnutrition

• **Surgery Related**
  - Hypothermia, OR time, drains, metal type, instrumentation to pelvis
Incidence of DSSI in different etiologies

- Neuromuscular: 116 (15%)
- Congenital: 69 (16%)
- Syndromic: 118 (10%)
- Idiopathic: 73 (3%)
- Other: 0

Deep Surgical Site Infection Following 2344 Growing-Rod Procedures for Early-Onset Scoliosis

Risk Factors and Clinical Consequences

- Xiau Rabinov, MD, Beltrame A, Abkarian, MD, Jeff B, Pavelski, JS, Mikal (ian), MD, Gregory M, Mando Jr, MD, Ricardo Fontan, MD, George H, Thompson, MD, David S, Marks, FRCS, FRCSI (England), Adrian Gardner, MBBS, FRCS (England), Paul B, Spengler, MD, MBA, David L, Skaggs, MD, MMM, and the Growing Spine Study Group
Risk Factors—Specific to EOS

- **Increased risk of infection:**
  - Stainless steel (OR=5.7)
    - 30/221 (13.6%) vs 12/150 (8%)
  - Non-ambulatory status (OR=2.9)
  - Number of revisions (OR=3.3)
VEPTR

Garg et al
Patient Related Risk Factors: Nutrition

- Lower infection in CP/Myelo:
  - Albumin >3.5 mg/dL
  - TLC >1500 cells/mm³
  - HCT>33g/L

- VEPTR population:
  - Low BMI (16.2)
  - Low ANC (8.2)

NOT PROVEN BUT PROBABLY APPLIES TO THIS POPULATION
Wound/Implant Contamination

- 23% positive intraoperative tissue cultures
- 9.5% contamination rate
  - Covered implants: 2%
  - Uncovered implants: 16.7%
What Do We Know?:
Reducing Risk with Intrawound Antibiotics

NO DATA FOR THIS POPULATION
Basic Science: Intrawound Vancomycin

- 20 rabbits laminectomy + wire placement
- Wound inoculated
  - Cefazolin and vanco sensitive *S. Aureus*
- Intrawound vanco given in half
- Tissue bacteria growth@ day 4
  - 39/40 and 0/40
What Do We Know?: Reducing Risk with Intrawound Antibiotics

- **Sweet et al:**
  - Infection rate 2.6% vs 0.2%

- **O’Neill et al:**
  - Vancomycin powder reduced risk 13% to 0% after traumatic injuries

- **Molinari et al:**
  - Low rate of infection (0.86%), no complications

- **Rahman et al:**
  - Infection rate 5% vs 0.7%, no complications
Other Favorable Studies

- **Strom et al:**
  - 10.9 → 2.5% C spine

- **Caroom et al:**
  - 15 → 0% C spine

- **Hill et al:**
  - 4 → 0% various procedures

- **Heller et al:**
  - 3.8 → 1.1% adult deformity
Wait a Minute….

- **Martin et al:**
  - Adult deformity surgery: 5.1% vs 5.3%

- **Ghobrial et al:**
  - High incidence of seromas and polymicrobial/gram negative

- **Tubaki et al:**
  - 1.68% vs 1.61% various adult surgeries
  - No difference if infection rate low?
Are we creating resistant organisms?
But What About Kids?

- 87 consecutive patients
- 500mg local vanco children >25 lbs
- Creatinine:
  - No change
- Serum Vanco:
  - Undetectable in serum day 1 and 4
Can We Use What We Know About Older Children?

What’s the Evidence? Systematic Literature Review of Risk Factors and Preventive Strategies for Surgical Site Infection Following Pediatric Spine Surgery

Michael P. Glotzbecker, MD,† Matthew D. Riedel, BA,‡ Michael G. Vitale, MD, MPH,† Hiroko Matsumoto, MA,† David P. Roye, MD,‡ Mark Erickson, MD,‡ John M. Flynn, MD,§ and Lisa Saiman, MD, MPH‖¶

<table>
<thead>
<tr>
<th>Grades of Evidence</th>
<th>Recommended Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A</td>
<td>Compared to autograft, ceramic bone graft substitute does not increase risk of SSI</td>
</tr>
<tr>
<td>Grade B</td>
<td>Gram-negative pathogens are more frequent in neuromuscular populations</td>
</tr>
<tr>
<td></td>
<td>Inappropriate perioperative antibiotic prophylaxis increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Increased implant prominence increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Compared to newer generation titanium implants, first-generation stainless steel implants increases risk of delayed SSI</td>
</tr>
<tr>
<td>Grade C</td>
<td>Blood loss increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Blood transfusions increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>No. levels fused increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Extension of fusion to the sacrum/pelvis increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Prolonged operative time increases risk of SSIType of allograft increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Use of drains reduces risk of SSI</td>
</tr>
</tbody>
</table>

SSI indicates surgical site infection.

TABLE 2. Association of Patient-related Risk Factors and SSI After Pediatric Spinal Surgery

<table>
<thead>
<tr>
<th>Grades of Evidence</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A</td>
<td>None</td>
</tr>
<tr>
<td>Grade B</td>
<td>Underlying medical condition/neuromuscular disease increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Urinary or bowel incontinence increases risk of SSI</td>
</tr>
<tr>
<td>Grade C</td>
<td>Positive urine culture increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Preoperative or postoperative malnutrition increases risk of SSI</td>
</tr>
<tr>
<td></td>
<td>Obesity increases risk of SSI</td>
</tr>
</tbody>
</table>

SSI indicates surgical site infection.
Outline

• **What is the problem?**
  – Infection rate, benchmarks, $$, current practice

• **What do we know?**
  – What are the risk factors?
  – What reduces infection risk?

• **Where are we going?**
  – Is there a consensus?

• **Treatment**
What is Current Practice?

- 19 question survey developed by authors
  - Survey monkey
  - Tested amongst authors prior to sending to group

- Sent to 57 GSSG and CSSG members
  - 40 responses (70%)
What is Current Practice?

• Significant Variability
Conclusions: Lots of Equipoise

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative MRSA screening</td>
<td>30.8% yes</td>
</tr>
<tr>
<td>Preoperative chlorhexidine baths</td>
<td>46.1% yes</td>
</tr>
<tr>
<td>Postoperative antibiotic duration after insertion</td>
<td>64.1% 24 hours or less</td>
</tr>
<tr>
<td>Use of topical antibiotics (vancomycin)</td>
<td>41% yes</td>
</tr>
<tr>
<td>Use of drains for insertion procedures</td>
<td>41.1% yes</td>
</tr>
<tr>
<td>Use of IV gram negative coverage</td>
<td>12.8% routinely</td>
</tr>
<tr>
<td>Use of perioperative IV vancomycin</td>
<td>5.1% routinely</td>
</tr>
<tr>
<td>Skin preparation</td>
<td>Betadine (23.1%) duraprep® (23.1%)</td>
</tr>
<tr>
<td></td>
<td>chloraprep® (61.5%) alcohol (38.5%)</td>
</tr>
</tbody>
</table>
Is There a Consensus?

"Then we are agreed nine to one that we will say our previous vote was unanimous!"
Best Practice Guidelines

• Need to strive to achieve best practices

• Reduce variability

Insanity: doing the same thing over and over again and expecting different results.

- Albert Einstein

www.quotesworthrepeating.com
Best Practice Guidelines

• Consensus statement for what is best practice
  – Systematic literature review (done)
  – Current practice survey (done)
  – ARS/Delphi method

  – Define steps to a work product
    – Is it possible in this population?
    – Should we just recommend using BPG for high risk?
# Best Practice Guidelines

## Building Consensus: Development of a Best Practice Guideline (BPG) for Surgical Site Infection (SSI) Prevention in High-risk Pediatric Spine Surgery

Michael G. Vitale, MD, MPH, Matthew D. Riedel, BA, Michael P. Glotzbecker, MD,†
Hiroko Matsumoto, MA,* David P. Bayne, MD,* Bohroz A. Akharnia, MD,‡
Richard C. Anderson, MD, FACS, FAPA, Denver, CO, Backstrom, MO.

*J Pediatr Orthop • Volume 33, Number 5, July/August 2013*

## TABLE 4. Final Best Practice Guidelines: Consensus Recommendations to Prevent Surgical Site Infections in High-risk Pediatric Spine Surgery

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Total</th>
<th>Strongly Agree</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Patients should have a chlorhexidine skin wash at home the night before surgery.*</td>
<td>91</td>
<td>61</td>
<td>30</td>
</tr>
<tr>
<td>2. Patients should have preoperative urine cultures obtained and treated if positive.*</td>
<td>91</td>
<td>26</td>
<td>65</td>
</tr>
<tr>
<td>3. Patients should receive a preoperative Patient Education Sheet.*</td>
<td>91</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td>4. Patients should have a preoperative nutritional assessment.*</td>
<td>96</td>
<td>57</td>
<td>39</td>
</tr>
<tr>
<td>5. If removing hair, clipping is preferred to shaving.†</td>
<td>100</td>
<td>61</td>
<td>39</td>
</tr>
<tr>
<td>6. Patients should receive perioperative intravenous cefazolin.*</td>
<td>91</td>
<td>65</td>
<td>26</td>
</tr>
<tr>
<td>7. Patients should receive perioperative intravenous prophylaxis for gram-negative bacilli.*</td>
<td>95</td>
<td>65</td>
<td>30</td>
</tr>
<tr>
<td>8. Adherence to perioperative antimicrobial regimens should be monitored (ie, agent, timing, dosing, redosing, cessation).*</td>
<td>96</td>
<td>61</td>
<td>35</td>
</tr>
<tr>
<td>9. Operating room access should be limited during scoliosis surgery whenever practical.*</td>
<td>96</td>
<td>61</td>
<td>35</td>
</tr>
<tr>
<td>10. Ultraviolet lights need not be used in the operating room.*</td>
<td>87</td>
<td>48</td>
<td>39</td>
</tr>
<tr>
<td>11. Patients should have intraoperative wound irrigation.*</td>
<td>100</td>
<td>83</td>
<td>17</td>
</tr>
<tr>
<td>12. Vancomycin powder should be used in the bone graft and/or the surgical site.†</td>
<td>91</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td>13. Impervious dressings are preferred postoperatively.†</td>
<td>91</td>
<td>56</td>
<td>35</td>
</tr>
<tr>
<td>14. Postoperative dressing changes should be minimized before discharge to the extent possible.†</td>
<td>91</td>
<td>52</td>
<td>39</td>
</tr>
</tbody>
</table>

*These interventions worked concurrently on the first round of voting.

†Denotes a change from the second round of voting.
Outline

• **What is the problem?**
  – Infection rate, benchmarks, $$, current practice

• **What do we know?**
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Growing Rods

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- **52% (22) implant removal**
  - Complete 13, partial 9

- **14/22 after first SSI, 8/22 after recurrence**

- **Average duration between initial detection of infection and implant removal 1.6 yrs**

- **74% (31/42) completed GR treatment (16) or were still lengthening (15) at latest follow up**
Final outcome at final FU

GR treatment terminated in 11 out of 42 patients (26%)

Category 1
- Continue Lengthening OR Completed Lengthening
- Timely Final Fusion
- Premature Final Fusion
- GR removed and patient observed or had non-op Tx
TABLE 2. Rate of Treatment Success With Debridement and Antibiotics

<table>
<thead>
<tr>
<th>Resolution</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial treatment</td>
<td>13</td>
</tr>
<tr>
<td>Second treatment</td>
<td>3</td>
</tr>
<tr>
<td>Third treatment</td>
<td>2</td>
</tr>
<tr>
<td>Fourth treatment</td>
<td>1</td>
</tr>
</tbody>
</table>

- 97 patients, 678 procedures
- 19 infections, 16 patients
- IV abx avg 58 day, oral 34 days
- None required implant removal
Outline

• **What is the problem?**
  – Infection rate, benchmarks, $$$

• **What do we know?**
  – What are the risk factors?
  – What reduces infection risk?

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• **Treatment**

- Infections expensive
- Rates too high
- True risk unknown
Outline

• What is the problem?
  – Infection rate, benchmarks, $$

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  – What are the risk factors?
  – What reduces infection risk?

• Where are we going?
  – Is there a consensus?

• Treatment

-Disease matters
-? Many factors to sort out
Outline

• What is the problem?
  – Infection rate, benchmarks, $$

• What do we know?
  – What are the risk factors?
  – What reduces infection risk?

• Where are we going?
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• Treatment
  -No consensus
  -Multicenter effort
  -CPG/SCAMPS needed
Outline

• What is the problem?
  – Infection rate, benchmarks, $$

• What do we know?
  – What are the risk factors?
  – What reduces infection risk?

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• Treatment
  May be able to retain implants and/or continue lengthening