What Do I Do to Reduce Infection Risk in EOS Surgery, and What I Do if I Have One

A. Noelle Larson, MD
Associate Professor
Pediatric Orthopedics and Scoliosis
Larson.noelle@mayo.edu
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Introduction

• Surgical site infection (SSI) after spine surgery can be a disastrous complication for patients, surgeons, and the healthcare system

• EOS patients are especially susceptible
Early Onset Scoliosis – High Risk

• Instrumentation to pelvis

• Sometimes nonverbal, preverbal

• High rate of comorbidities

• Need multidisciplinary team
  • Pulmonology, nutrition, anesthesia, social work, PT, OT
Know Your Bad Actors

- G-tube
- Tracheostomy
- Incontinent urine/stool (Glotzbecker MP et al., JPO 2013)
- Indwelling Foley/self-cathing
- Ventilator dependence
- Nonverbal
- Nonambulatory
- Insensate
- Kyphosis
Neuromuscular Scoliosis - Nonambulatory

- Wheelchair seating
- 14-50% 2 Year reoperation rate on neuromuscular spine patients
Too Heavy
Rigid spine myopathy
BMI 13
Too Light
Infection from Poor Skin Coverage, Chronic Disease State

• Bess, JBJS 2010, growing rods for young children
  • Subcutaneous dual rods (13/51) had more wound complications than did those with submuscular rods (9/88), also more prominent implants, and more unplanned surgical procedures (p ≤ 0.05).
How to Avoid Infection
Avoid loose/prominent implants

- Sets up a bursa, increased risk of infection
  - Osteomyelitis experiments, injury → increased susceptibility to local infection
- Prominent implants in AIS associated with infection
Treat Acne! Treat Pruritis!

- No problems operating through Accutane
- Preferred treatment, but needs to be started 2-3 months in advance
- Don’t let patients scratch in the hospital (naloxone drip, antipruritics)
SMA/Nutritional Concerns Day of Surgery

- Nutritional drink until 2 hr prior to surgery (unless ketogenic diet, specially SMA)
- Bronchoscopy, fiberoptic intubation
- Place PICC line intraoperatively or preop
- Start total parental nutrition during surgery
Compulsive About Antibiotic Dosing

- Adherence with periop antibiotics matters
  - Vandenberg C, Garg S et al., JPO 2016.
- If allergic to pencillins, preop allergy testing.
  - vanco + clinda
  - Cefazolin is best
    - 30% higher rate of joint infections if alternative antibiotic is used
  - Wyles, Bone J J, 2019
Avoid Growing Rods
Age 13 months to 8 years with no surgery (no infection)
Avoid Growing Rods
Age 4 to 11, with one surgery
Intraoperative Preventative Measures

Secure all Lines and Wound Edges
Minimize trauma on wound edges

Careful retractors, insulated electrocautery tip

Extend incision if needed.
Intraoperative Preventative Measures

- Superficial drain for long exposures
  - Has been shown to decrease spotting on dressing in AIS
- Cover implants
- Irrigate, change gloves prior to placing implants
- Beware C-arm
- Layered closure
  - (I am present)
Dilute Betadine Soak

4 Minutes (I do it during final x-ray/fluoro films)

Then irrigate after.

• Tomov M et al., Spine 2015
• Cheng MT, Chang M et al. Spine 2005
When Infection Strikes

- Multiple debridements
- IV antibiotics
When Infection Strikes

- Multiple debridements
- IV antibiotics
- Wound vac with retention sutures (don’t allow tissues to retract)
- Monofilament sutures, drains, nylons, consider plastics surgery consultation
- Remove braided sutures / sublaminar tapes
Age 6 to 15 years

Peri-implant Yeast Infection
When Infection Strikes

- Forthright discussion with family
  - Prolonged hospitalization
  - Optimize risk factors
  - PICC
  - Chronic suppression
  - Try to make friends!
    - Learn siblings names
    - Bring visitors
    - Show empathy!
Stainless?

- Increased delayed infection with stainless implants (LaGreca et al., Sp Def, 2014), primarily Propionibacterium
  - Also harder to treat if gets infected (Glotzbecker MP et al., Spine Def 2016)
Role of Vancomycin Powder in Treatment of Established Infections

Chenghao Zhang, MBBS, PhD; Andre Van Wijnen, PhD; Thomas Boyce, MD; Robin Patel, MD; A. Noelle Larson, MD; Todd Milbrandt, MD

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• Rat model of spinal implant associated infection (methicillin resistant Staphylococcus epidermidis)

• How would the vancomycin powder vs. microspheres perform with biofilm and implant related infection?
Microsphere Spray System for Wound Coverage

- Treatment of an infection (~6 weeks)
  - PLGA microspheres were prepared using a double emulsion procedure
  - Vancomycin was absorbed and adsorbed onto the surface of microspheres for delayed release

![Graph showing Vancomycin Concentration (ug/ml) over Duration (Days)]
Electron microscopy of biofilm

1 ml of $10^5$ cfu S. epidermidis RP62A
14 mm x 1 mm threaded Kirschner wire
**In vivo model**

- Four groups
  - No treatment
  - Vancomycin powder
  - Blank microspheres
  - Vancomycin-loaded microspheres
- Vancomycin powder concentration
  - Based on human application
  - 1 g for 44 cm x 6 cm (human)
  - 7.5 mg for 2 cm x 1 cm (rat)
Results: Wire culture (similar for tissue and fastener)
Concerns Regarding Effects of Topical Vancomycin

• Vancomycin could affect cell death, gene expression, and new bone formation for stem cells.
• Vancomycin exposure will affect adipose tissue-derived mesenchymal stem cell function, including differentiation, proliferation and apoptosis.
Topical Vancomycin Application – Few Systemic Effects

- The local effects of application of vancomycin powder also need to be evaluated.

Vancomycin serum levels are near undetectable within 24 hours after surgery. (R² = 0.11).

Local levels of vancomycin decrease in a time-dependent manner (R² = 0.35).

Adipose-Derived Stem Cell Response to Vancomycin Concentration (24 Hours)

- Adipose tissue-derived mesenchymal stem cells were plated and exposure to vancomycin in varying concentrations for 24 hours.
Adipose-Derived Stem Cell Response to Varying Vancomycin Concentrations over 24 Hours

The graph shows the percentage of live cells versus control over exposure time (in hours) for varying concentrations of vancomycin. The concentrations tested are 40 mg/mL, 20 mg/mL, 5 mg/mL, and 0 mg/mL. The live/dead staining images correspond to these concentrations at different exposure times, with red indicating dead cells and green indicating live cells.
Varying Vancomycin Concentrations for 24 Hours (Red) vs. 1 Hour with 23 Hours of Recovery (Green)
Change in Gene Expression During Vancomycin Exposure

Cell proliferation → MKI 67, HIST2H4, Cyclin B2

- **MKI-67**
  - RNA Expression % vs. Concentration of Vancomycin (mg/mL)
  - Treatment group vs. Recovery group

- **HIST2H4**
  - RNA Expression % vs. Concentration of Vancomycin (mg/mL)
  - Treatment group vs. Recovery group

- **Cyclin B2**
  - RNA Expression % vs. Concentration of Vancomycin (mg/mL)
  - Exposure group vs. Exposure + Recovery group
Part 3: Change in Gene Expression During Vancomycin Exposure

Extracellular matrix → COL1A1, COL3A1

### Col1A1
- RNA Expression vs. Concentration of Vancomycin (mg/mL)
- Significance marked with *

### Col3A1
- RNA Expression vs. Concentration of Vancomycin (mg/mL)
- Exposed group vs. Exposure+Recovery group
Increased vancomycin concentration reduced osteoblastic differentiation
Discussion

- Topical vancomycin very effective at eliminating chronic implant-associated MRSE infection

- High concentrations of vancomycin reduced the cell proliferation and **osteoblastic differentiation**, which may be concerning for fusion.
Summary

• Many bugs
• Various strategies

• Need constant vigilance
  • Role for new technology, high quality prospective research
Thank you!

A. Noelle Larson, MD
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