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

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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

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

Risk Factors and Clinical Consequences

Nima Kabirian, MD, Behrooz A. Akbarnia, 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. Sponseller, MD, MBA, David L. Skaggs, MD, MMM, and the Growing Spine Study Group

Investigation performed at the San Diego Center for Spinal Disorders, San Diego, California

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Early Onset Scoliosis – High Risk

- Instrumentation to pelvis
  - Glotzbecker MP et al., JPO 2013. Mistovich RJ et al. , JBJS Rev. 2017.
- Sometimes nonverbal, preverbal
- High rate of comorbidities
- Need multidisciplinary team
  - Pulmonology, nutrition, anesthesia, social work, PT, OT

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Know Your Bad Actors

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

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- Insensate
- Kyphosis

Neuromuscular Scoliosis - Nonambulatory

- Wheelchair seating
- 14-50% 2 Year reoperation rate on neuromuscular spine patients

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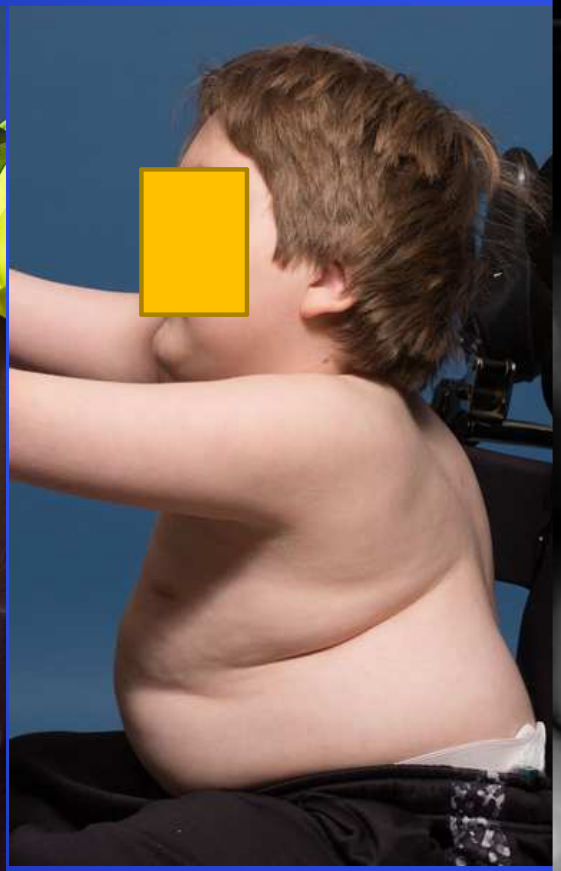
Too Heavy



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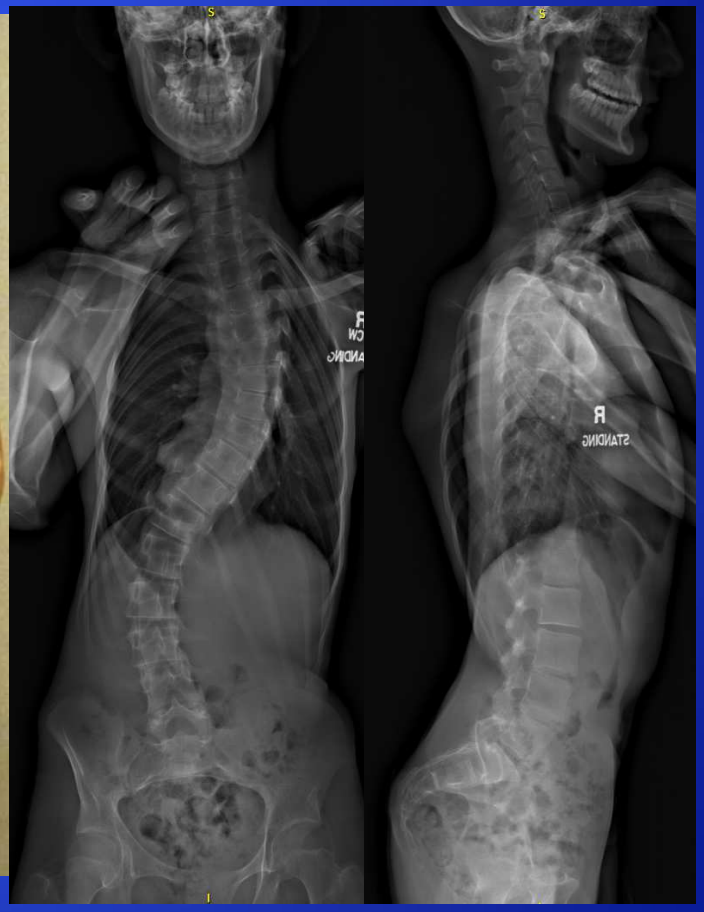
Too Light



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Calvin Kle


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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 ($p \leq 0.05$).

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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
    - Mistovich RJ et al. JBJS Rev. 2017.

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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)

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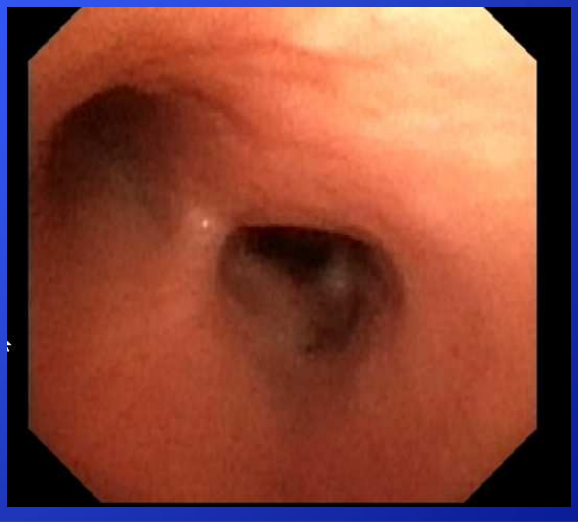
SMA/Nutritional Concerns
Day of Surgery

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



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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

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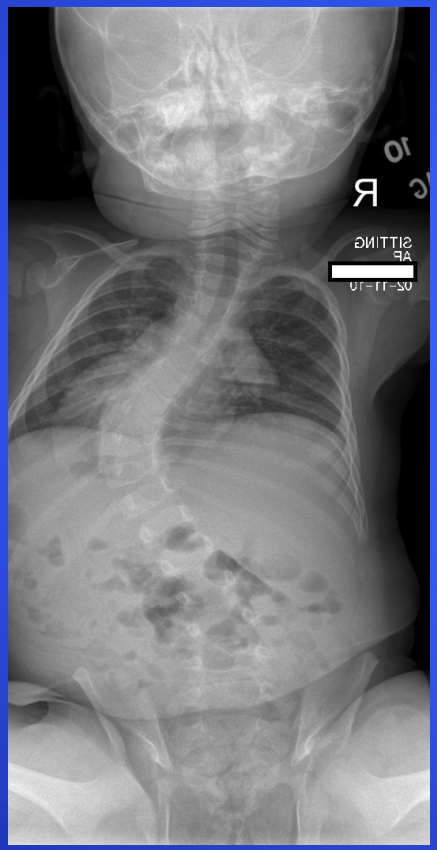
Avoid Growing Rods
Age 13 months to 8 years with no surgery (no infection)



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Avoid Growing Rods
Age 4 to 11, with one surgery

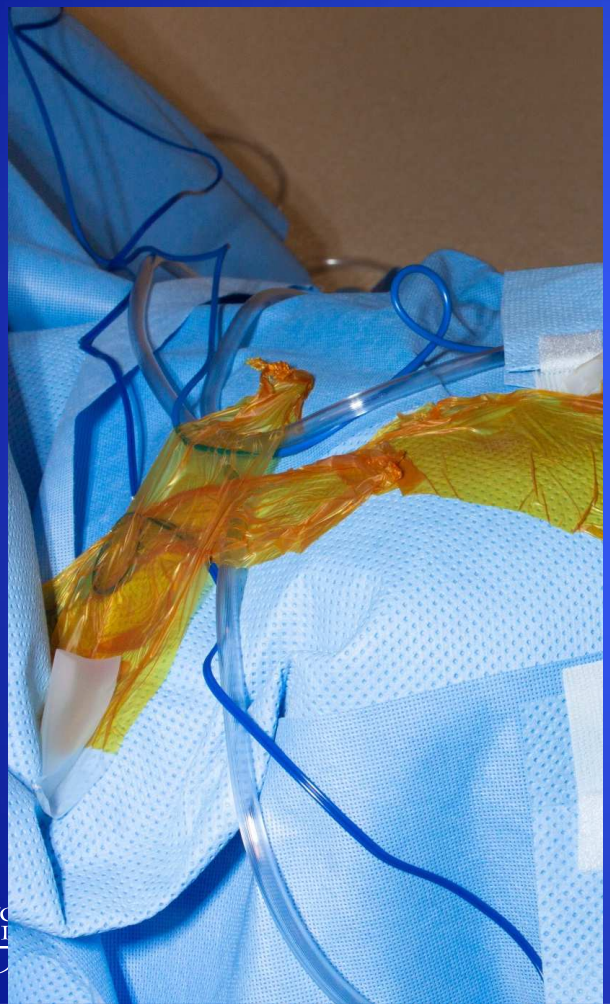
2011

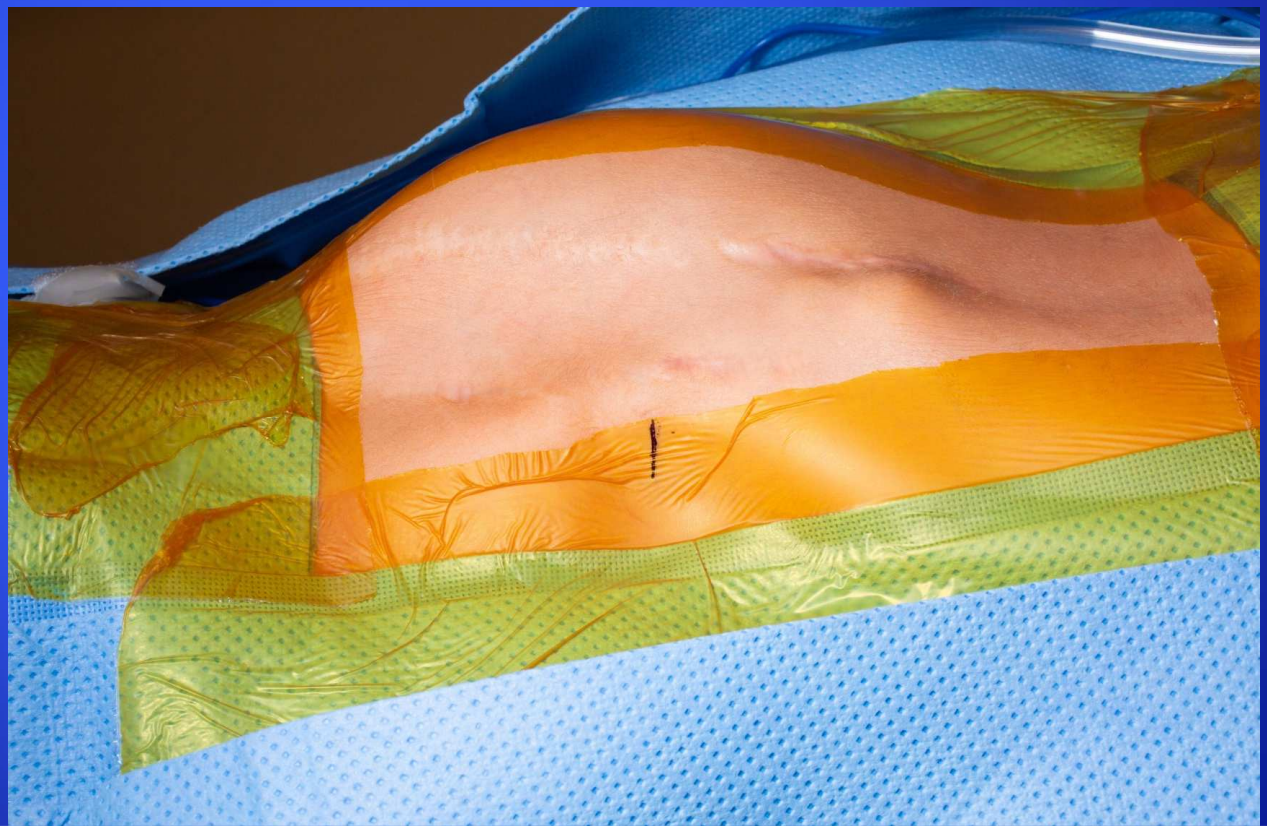
2014

2019

Intraoperative Preventative Measures

Secure all Lines and Wound Edges





Minimize trauma on wound edges

Careful retractors, insulated electrocautery tip

Extend incision if needed.

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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)

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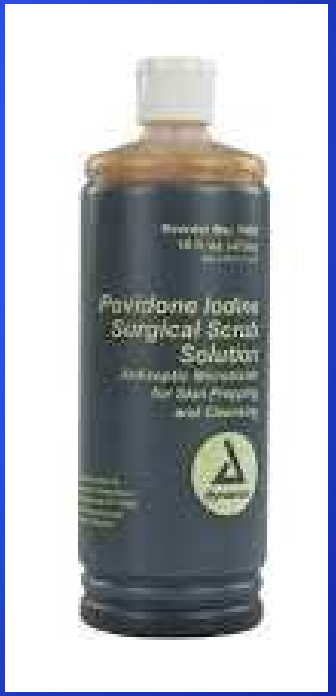
Dilute Betadine Soak

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



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When Infection Strikes

- Multiple debridements
- IV antibiotics

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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

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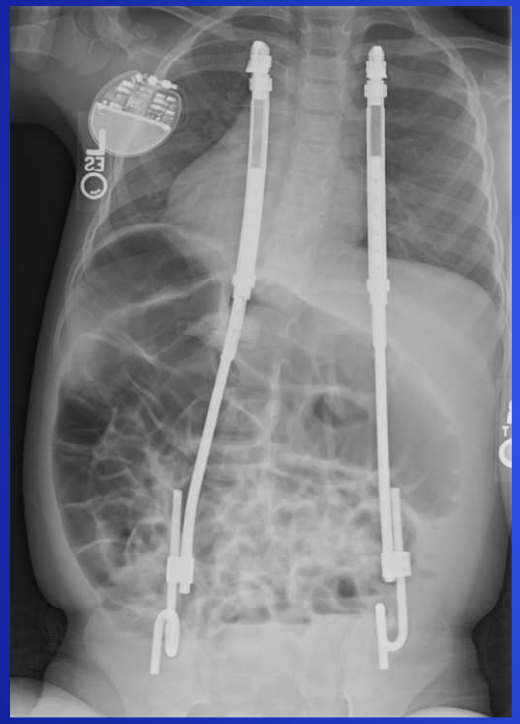
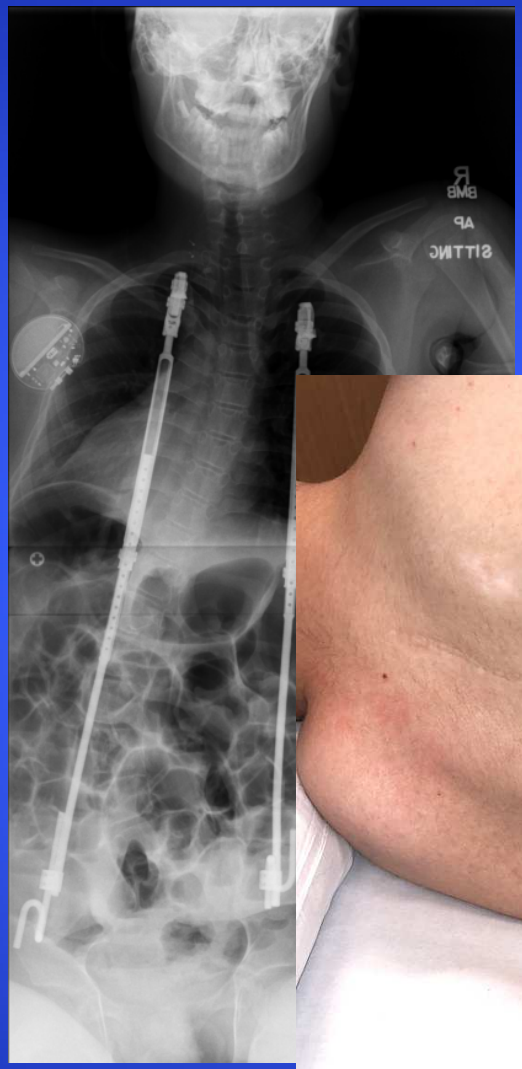
Age 6 to 15 years





Peri-implant Yeast Infection

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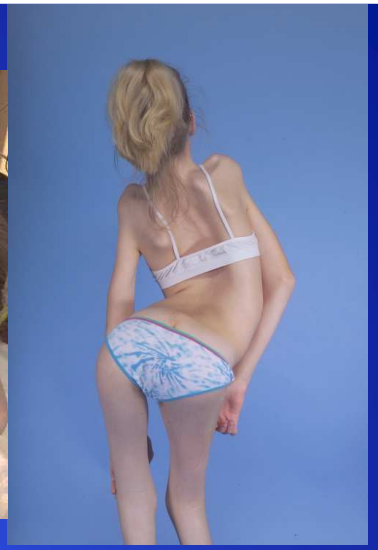
When Infection Strikes

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



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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)

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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

Supported by Mayo Clinic Benefactor Grant for Pediatric Infectious Disease

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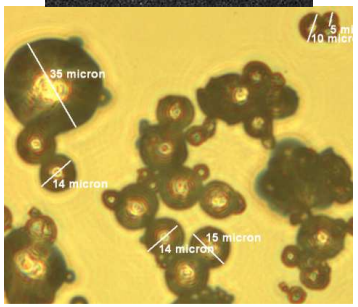
- Rat model of spinal implant associated infection (methicillin resistant *Staphylococcus epidermidis)*
- How would the vancomycin powder vs. microspheres perform with biofilm and implant related infection?



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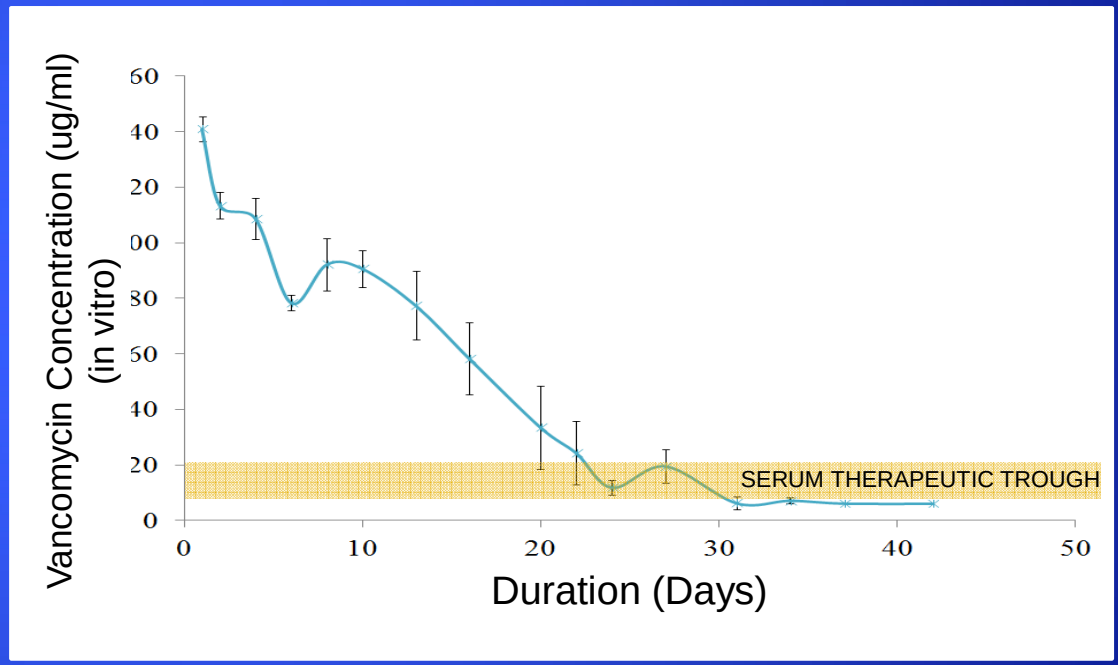
Microsphere Spray System for Wound Coverage

- 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



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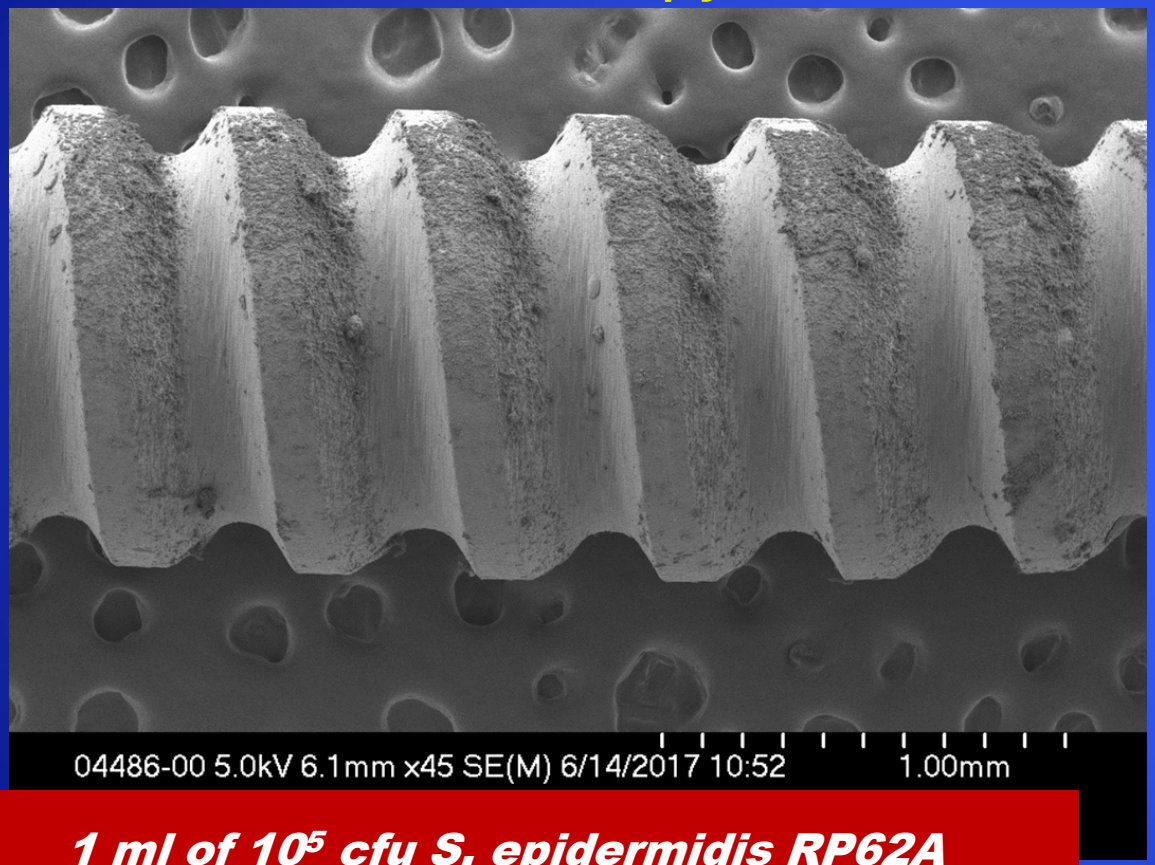
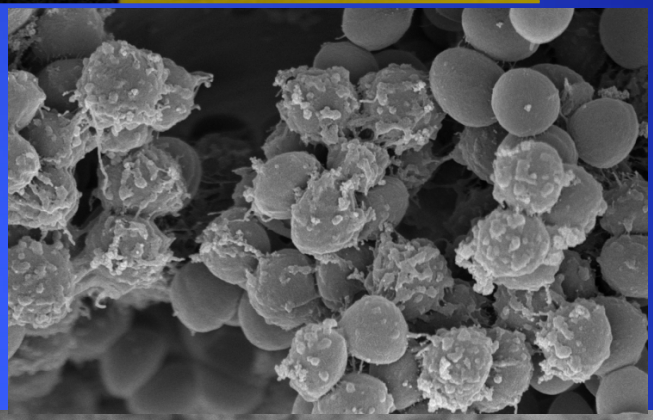
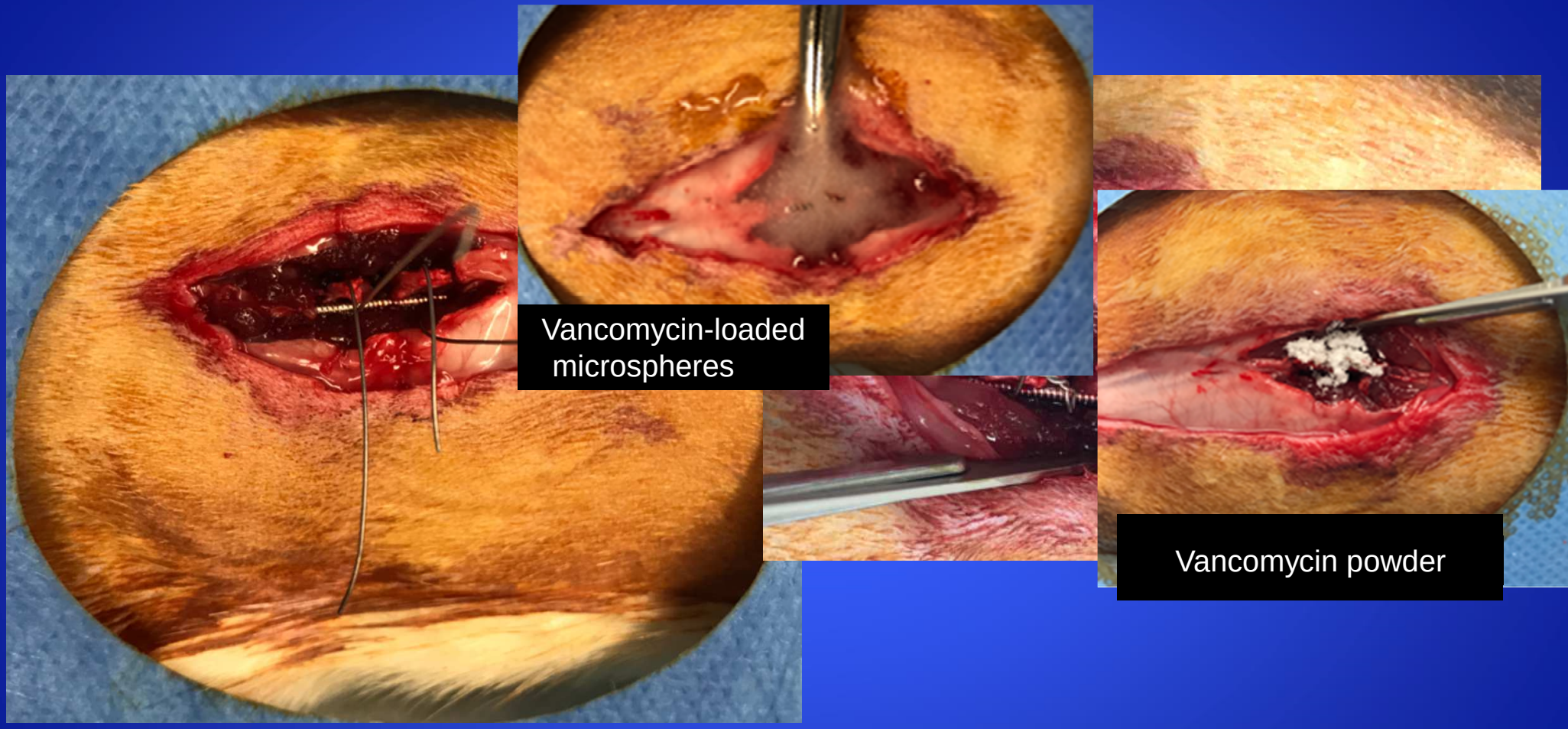
Electron microscopy of biofilm





1 ml of 10^5 cfu S. epidermidis RP62A
14 mm x 1 mm threaded Kirschner wire



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In vivo model

- Four groups
  - No treatment
  - Vancomycin powder
  - Blank microspheres
  - Vancomycin-loaded micros
- 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)

Vancomycin-loaded microspheres

Vancomycin powder

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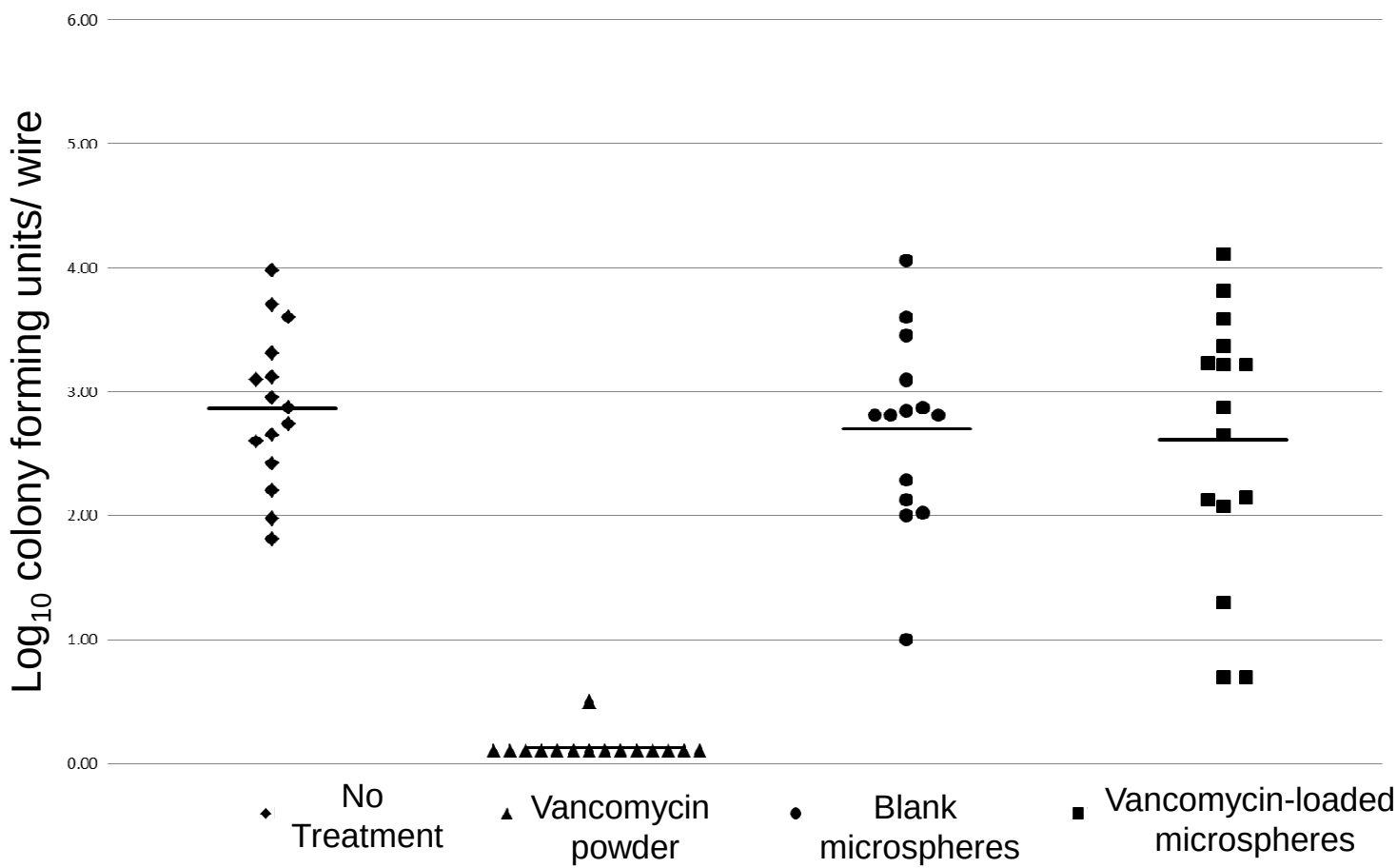
Results: Wire culture (similar for tissue and fastener)



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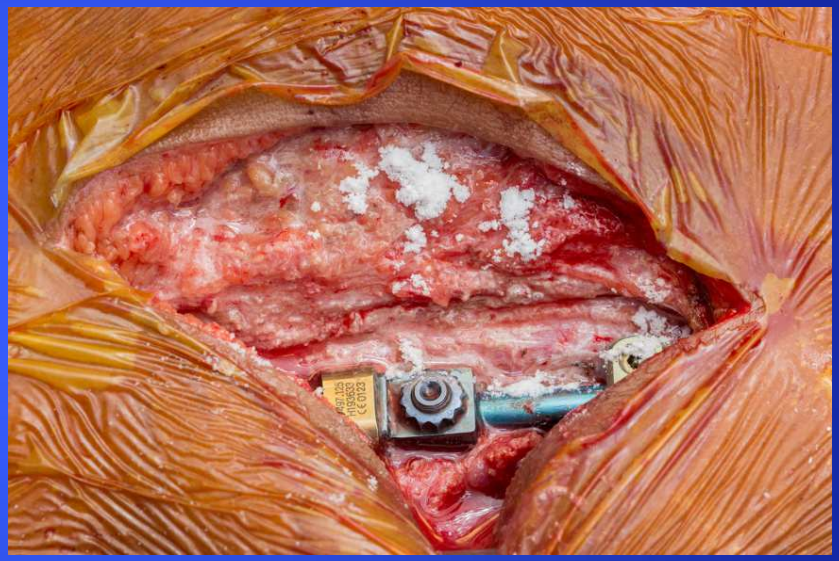
Concerns Regarding Effects of Topical Vancomycin

- 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.



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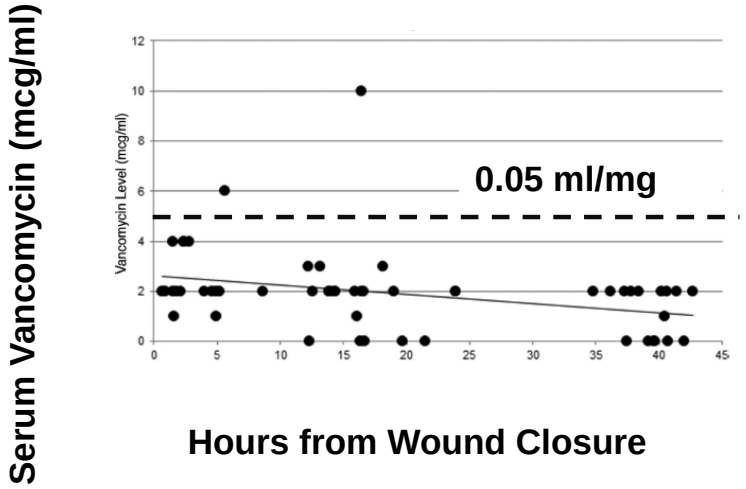
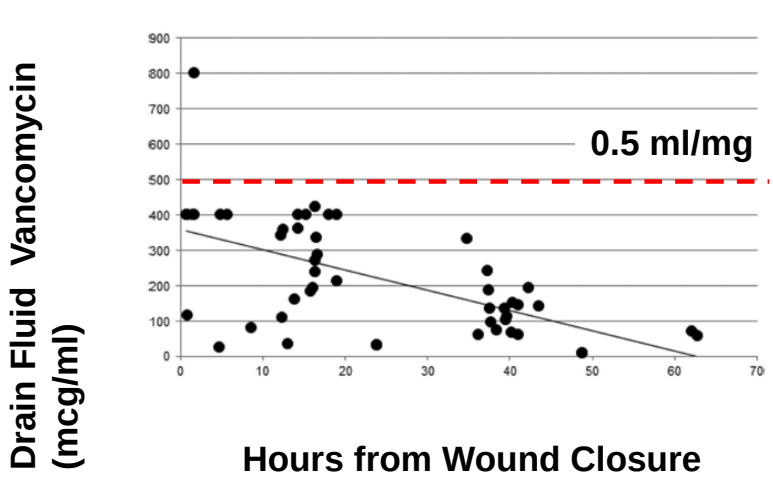
Topical Vancomycin Application – Few Systemic Effects

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





Vancomycin serum levels are near undetectable within 24 hours after surgery. ($R^2 = 0.11$).

Local levels of vancomycin decrease in a time-dependent manner ($R^2 = 0.35$).

Armaghani, S. J. et al. Spine (Phila Pa 1976). 2014

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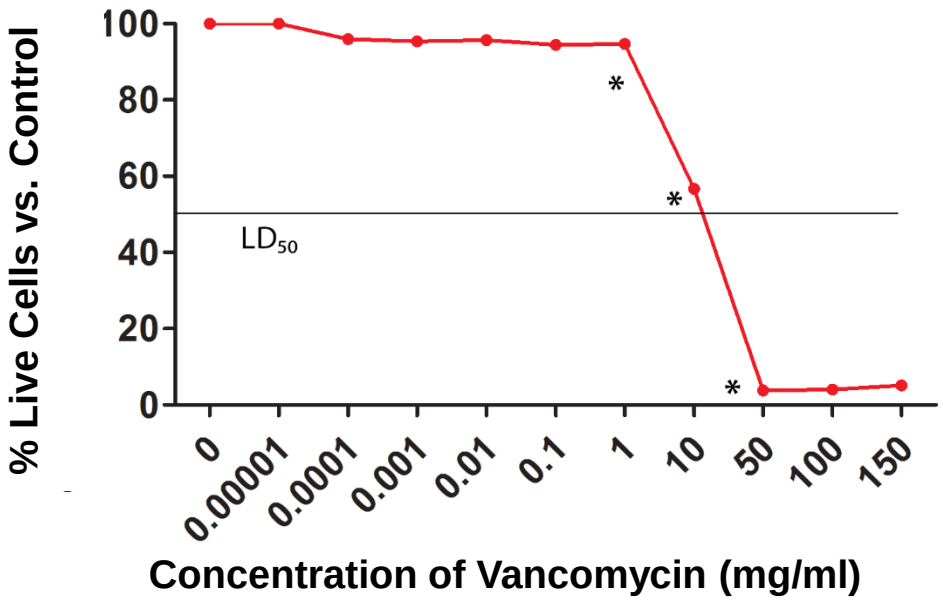
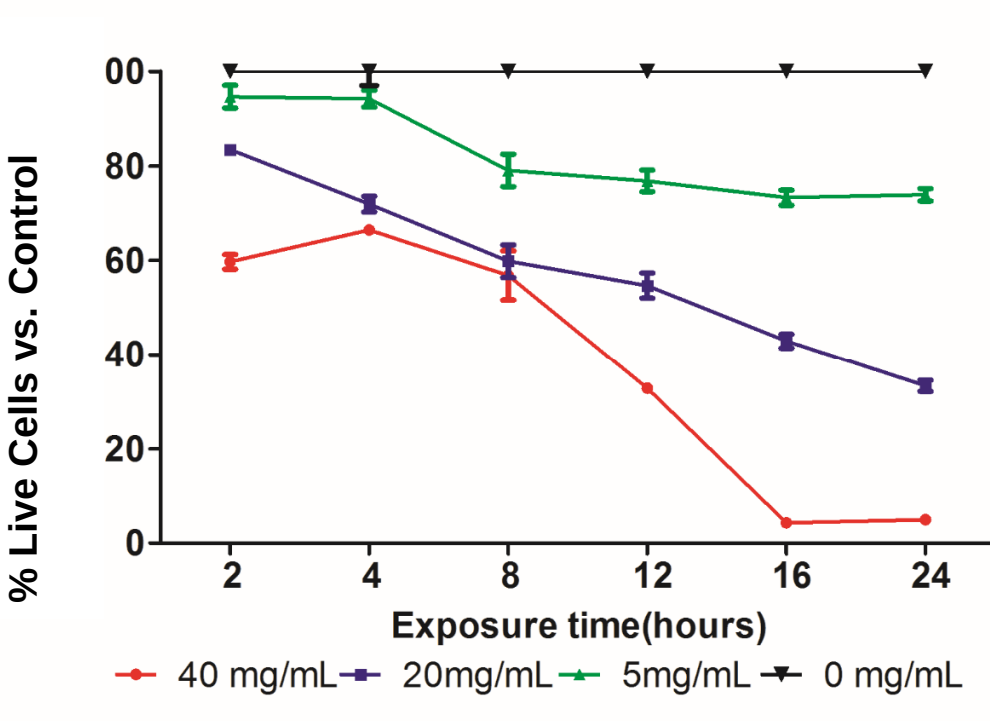
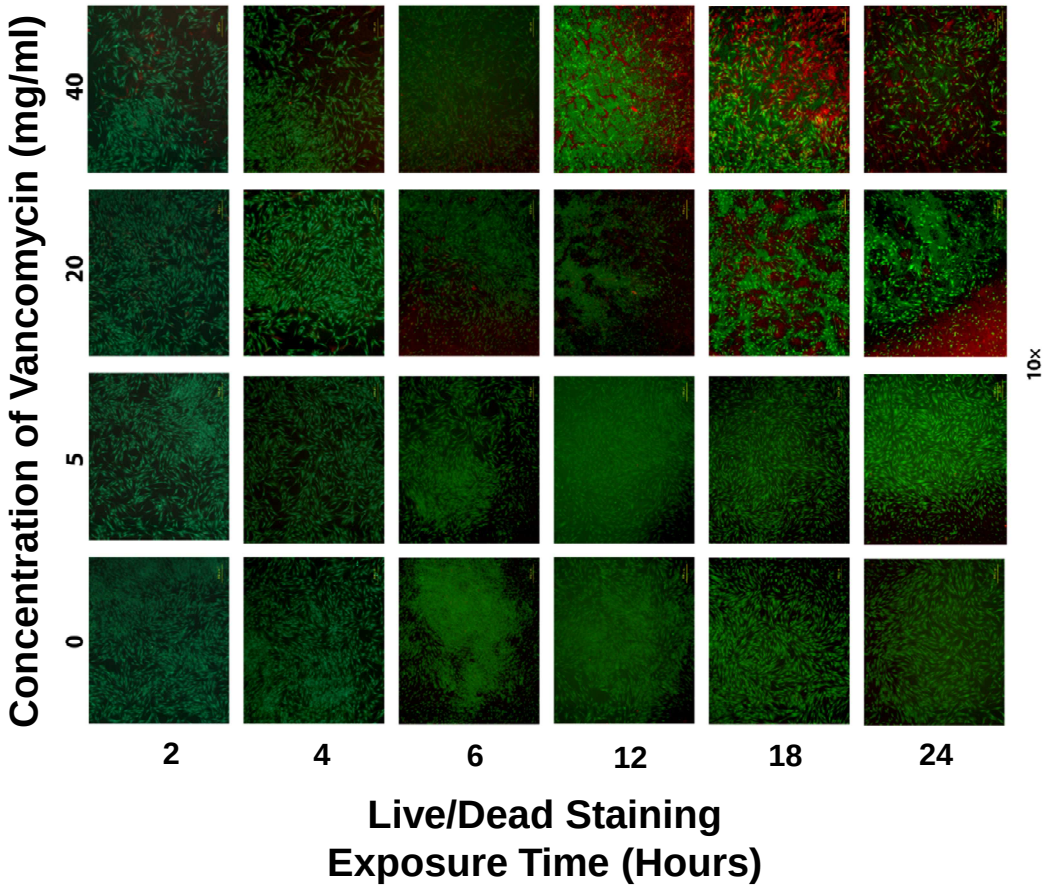
Adipose-Derived Stem Cell Response to Vancomycin Concentration (24 Hours)



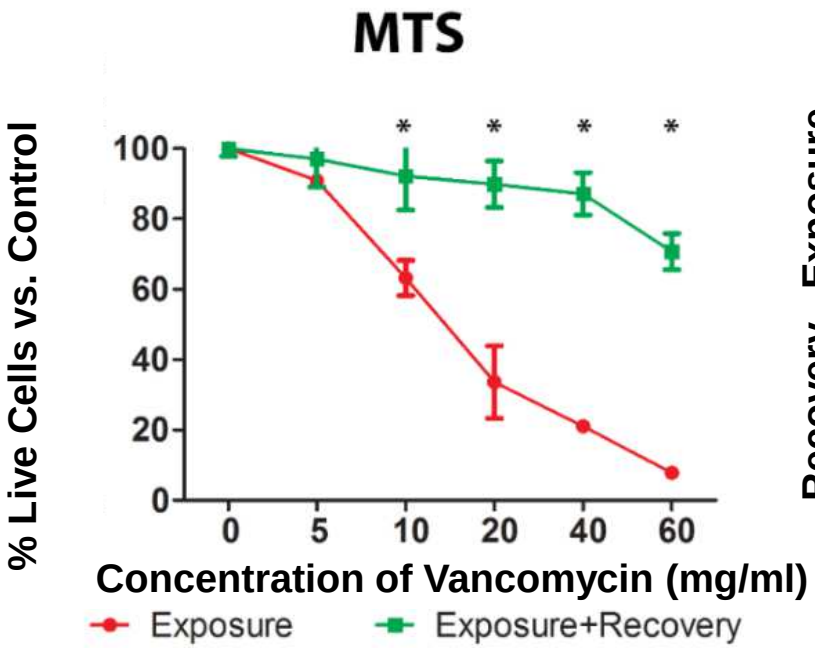
- Adipose tissue-derived mesenchymal stem cells were plated and exposure to vancomycin in varying concentrations for 24 hours.

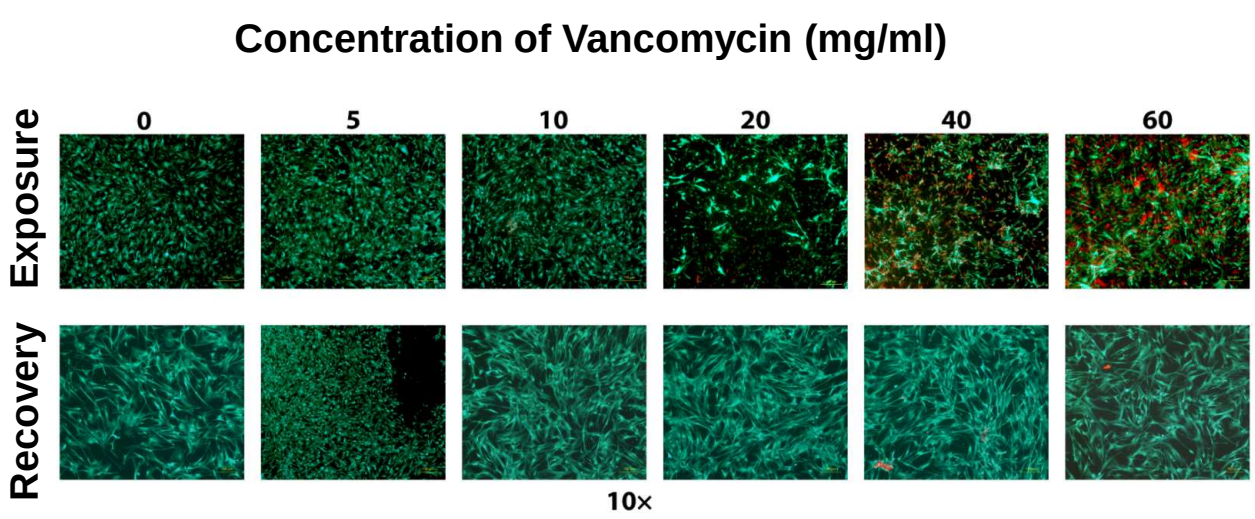
Adipose-Derived Stem Cell Response to Varying Vancomycin Concentrations over 24 Hours





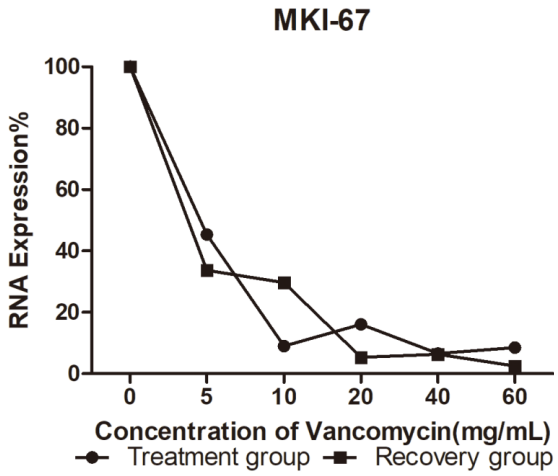
Varying Vancomycin Concentrations for 24 Hours (Red) vs. 1 Hour with 23 Hours of Recovery (Green)

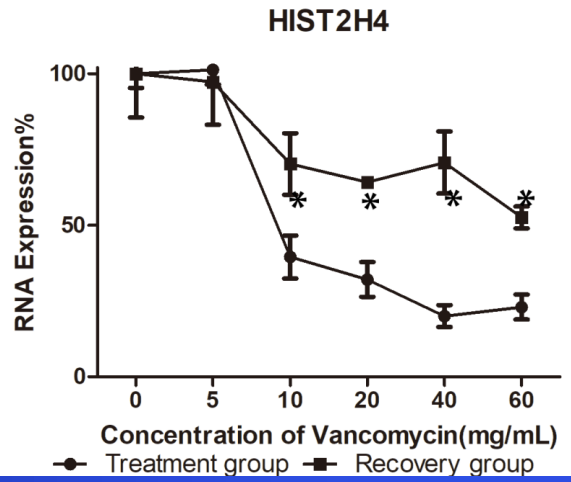


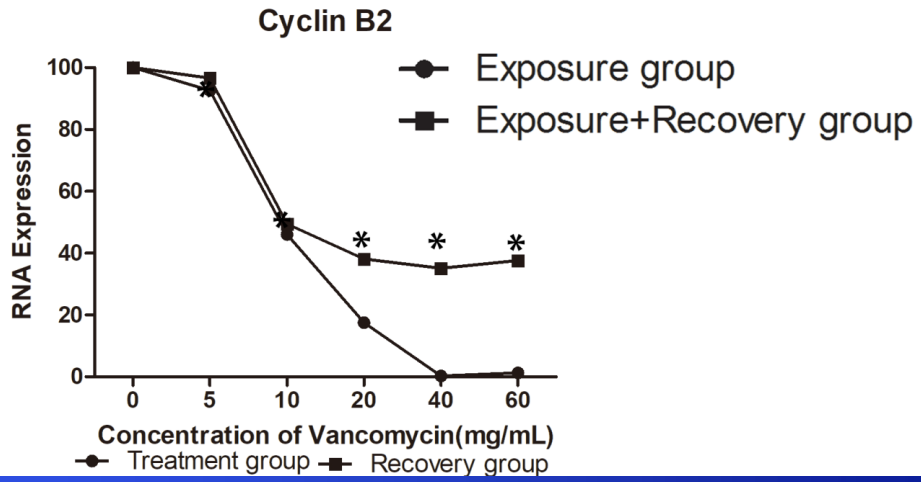


Change in Gene Expression During Vancomycin Exposure

Cell proliferation → MKI 67, HIST2H4, Cyclin B2 ↓







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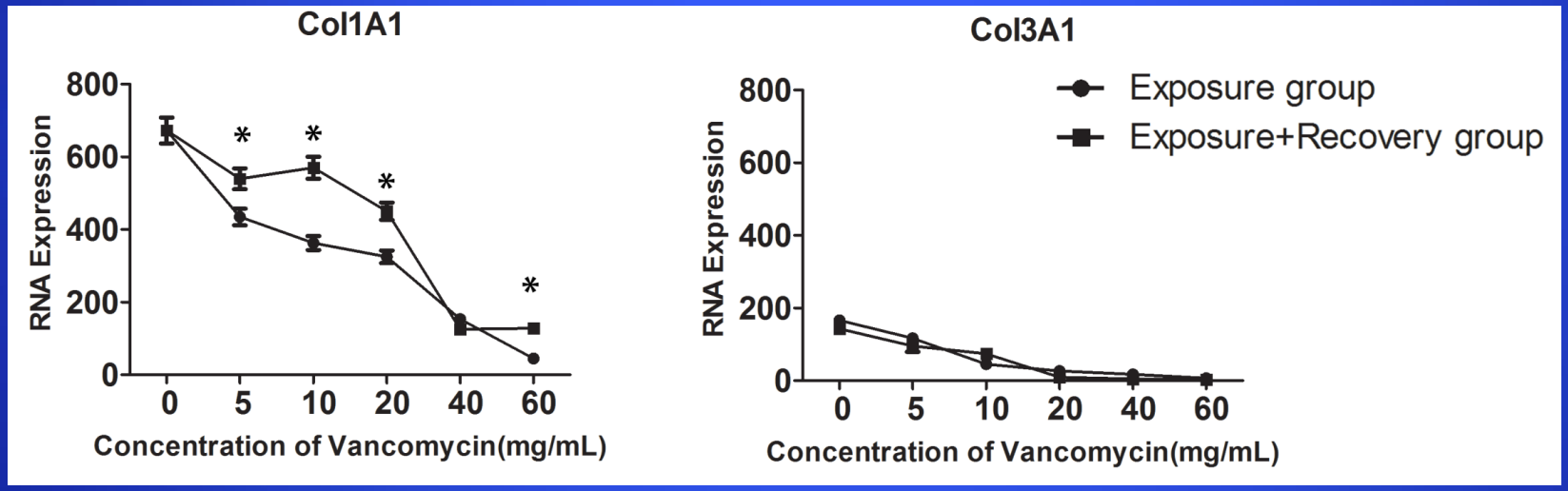
Part 3: Change in Gene Expression During Vancomycin Exposure

Extracellular matrix → COL1A1, COL3A1 ↓



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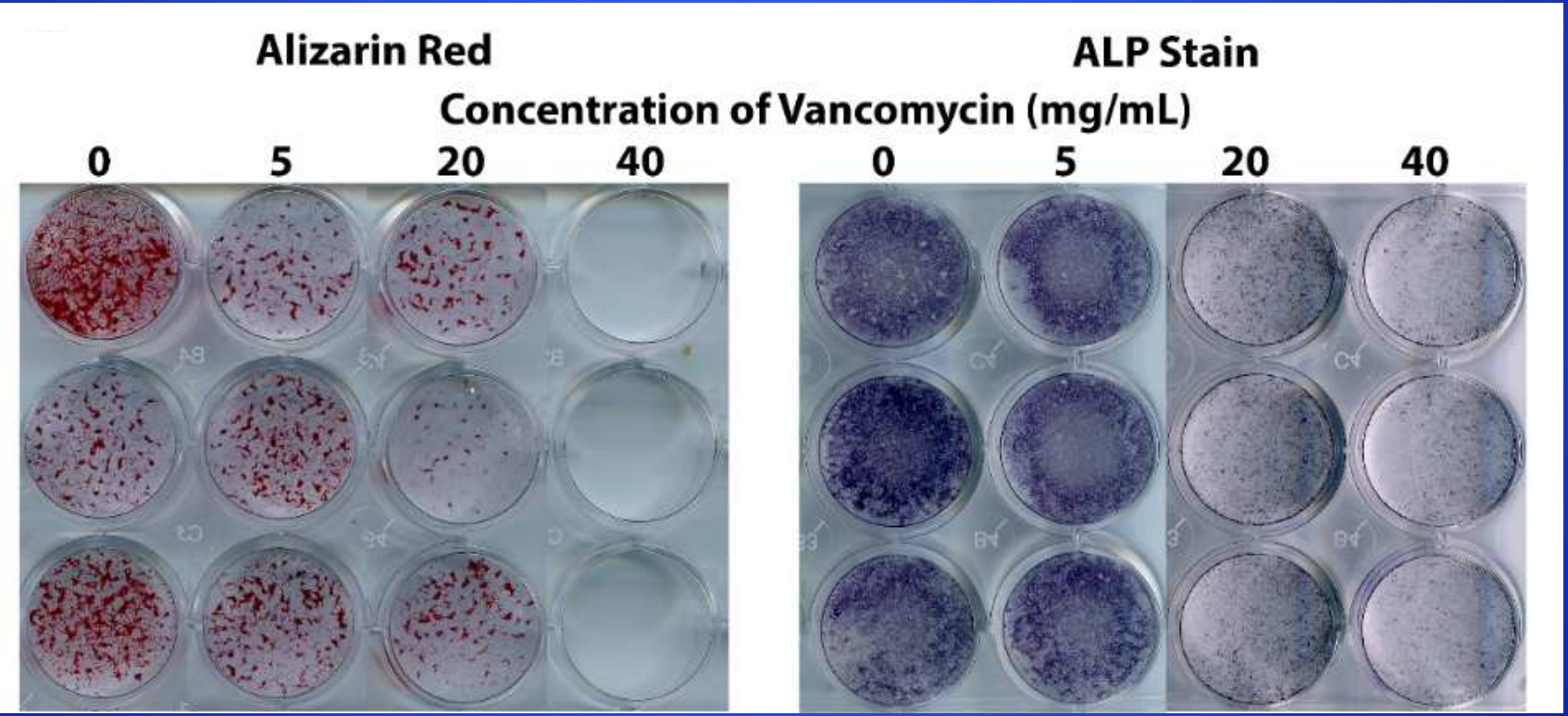
Increased vancomycin concentration reduced osteoblastic differentiation



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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.

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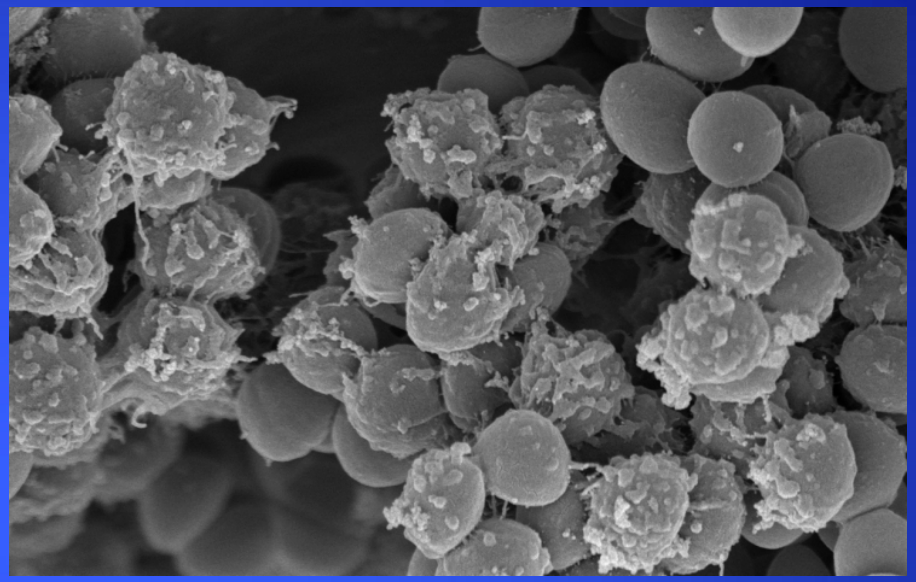
Summary



- Many bugs
- Various strategies

- Need constant vigilance
  - Role for new technology, high quality prospective research

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Thank you!

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