Periprosthetic Joint Infection
VuMedi Webinar

• Draping procedures to Reduce Infection – Sah
• Methods of Diagnosis- Sporer
• Antibiotic lavage to reduce infection and Local Ab infusion- Whiteside
• Management of bone loss in Rev TKA- Malkani
• Intro and discussion- Jones

Key Article Costs of PJI

• The Journal of Arthroplasty
• Economic Burden of Periprosthetic Joint Infection in the United States
  - Steven M. Kurtz, PhD⁎,†, Edmund Lau, MS‡, Heather Watson, PhD‡, Jordana K. Schmier, MA§, Javad Parvizi, MD‖

PJI Costs to Healthcare USA

• 2- 2.4 % rate
• $320 M [2001]
• $566 M [2009]
• Demand continues to increase
• Economic burden will also increase
• $1.6 B [2020]
J Arthroplasty Supplement

• Vol 29, # 2; Suppl. 1
• February 2014
• Proceedings of International Consensus on Periprosthetic Joint Infection
• Benchmark, Gold Standard Statements on PJI

Reference Guide
Draping Approaches to Reduce Infection
Pre, Peri, and Post Surgery

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February 5th, 2015

Sterile Technique

• Identify areas of risk
  • Changing personnel
  • Type of procedure
  • Habits
  • No one will care more about sterility than surgeon

• OR Staff
  • Standard protocols
  • Sterile area
  • Watching contamination of back
  • Space suits and false security

Room Traffic

• Well established that people are major source of bacteria
  • Limiting traffic minimizes CFU counts, but correlation between traffic and surgical site infection limited
  • Operating room door openings at 60 for 92 minute primary, and 136 for 161 minute revision (Panahi, Austin. CORR 2012)
Skin Preparation

- Alcohol containing antiseptic for skin prep
  - Shower with chlorhexidine at least once prior to surgery (1999 HICPAC guidelines)
  - Maximal effect occurs with repeated washes
  - Prepp wipes, benefit of CHG to remain on skin to be effective
  - Chlorhexidine or iodophor, plus alcohol
  - Prepared area from center to outside proposed surgical area (including possible drain sites)
  - Ensure area is completely dry prior to draping

- Contamination during skin prep and draping
  - Bacterial air counts higher when leg holder is unscrubbed, ungowned
  - Recommended instrument packs opened only after skin prep and draping complete
  - Brown, Gregg. JBJS Br. 1996

- Risk of fingertip contamination during draping
  - Bacterial contamination isolated from 15.2% of gloves
  - More often on dominant hand, in less experienced staff
  - Recommend changing gloves after draping

- Stockinette over a non-prepped foot
  - In simulated surgical field, all specimens showed proximal contamination if stockinette applied over a nonprepped foot
  - No contamination in specimens if foot disinfected
Incise Draping

- Sticky barrier over prepped surgical area
  - With or without iodophor
  - Surgical incision made through this barrier
  - Provides mechanical barrier preventing skin flora
  - Skin prep should promote durable adherence
  - Decrease skin bacterial counts, but unclear affect on SSI
  - Separation of drapes or excessive moisture underneath may increase infection rate
  - Cochrane meta-analysis: no clear evidence that iodine impregnated adhesive drapes reduce SSI
- Repeat skin antisepsis may reduce SSI
  - Repeat antisepsis after surgical draping but before incise draping may reduce SSI (6.5% down to 1.8%); AAOS 2014 funded by 3M

Drapes

- Protective barriers against microorganisms, particulates, fluids
  - Pressure can result in liquid and dry penetration of microbes
  - Drapes should be resistant to tears, punctures, abrasions
  - As long as impermeable, then cloth versus disposable equivalent
  - Sticky-U drapes is typical practice, but no data

Surgical Attire

- Disposable versus cotton gowns
  - Disposable gowns showed marked reduction in rate of SSI compared to permeable cotton gowns and drapes
  - No difference in rate between impermeable disposable and reusable gowns
  - Skin prep should promote durable adherence
- Space Suits
  - Literature is divided on efficacy of space suits in reduction of bacteria particles in OR
  - Some evidence that space suits may actually be associated with higher rates of SSI
- Masks
  - Literature does not show reduced surgical site infection with masks
  - Current OSHA regulations and universal precautions require them
**Gloves**

- Contamination of outer gloves is common (approximately 30%)
  - Similar across all scrubbed personnel
  - Double gloving reduces number of holes in inner glove, does not reduce contamination levels of outer glove
  - Cochrane eta-analysis also showed fewere perforations of inner glove with multiple layers
  - Skin prep should promote durable adherence

- Glove perforation time and frequency
  - glove perforations occurred in 19 of 57 THA procedures (33%)
  - 32 perforations in 979 gloves
  - Recommend two pairs of gloves, and changing when gloves contaminated with surgical fluids or average 90 minutes

**Back Table**

- Instruments and fluids can harbor bacteria
  - Splash basins to rinse instruments often cited as source of infection (2-74%)
  - Irrigation fluid on back table can also become contaminated (62% if case over 1hr)
  - Surgical instruments can become contaminated (15% @ 1hr, 32% @ 4hrs)
  - Open trays covered by a sterile towel did not become contaminated
  - Changing suction tips every hour

**Surgical Dressing**

- Occlusive dressing
  - Lower blistering rate
  - Fewer dressing changes
  - Some studies show lower SSI rate
References

- Salassa, Swiontkowski. Surgical Attire and the Operating Room. JBJS, 2014;96(17):1485
- Proceedings of the International Concensus Meeting on Periprosthetic Joint Infection
Periprosthetic Joint Infection: Diagnosis

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Associate Professor of Orthopaedic Surgery
Rush University Medical Center Chicago, IL

Co-Medical Director Joint Replacement Institute
Cadence Health

Prevalence

- Infection is among the more common causes of failure and revision in TKA/THA
  - 1/3 of my revision TKA/THA
  - Overall 1-2% of all TKA/THA

Financial Disclosure

- Consultant: Zimmer, Smith & Nephew
- Research Support: Zimmer, Cadence Health
- Royalties: SLACK
- Board: American Joint Replacement Registry
Risk Factors: Host

• Prior surgery
• Inflammatory Arthritis
• Steroid dependent
• Diabetes
• Renal insufficiency (dialysis)
• Skin disorders (psoriasis)
• Malnourished
• Otherwise immunocompromised

Patient Evaluation: Physical Exam

• Carefully inspect the incision
  – Erythema?
  – Prior healed sinus?
  – Multiple incisions?
• Difficulty closing the wound?

Plain X-rays

• Rarely show evidence of infection
  – Periosteal reaction
  – Osteolysis
  – Loose implants
  – Suspect infection if rapid loosening of an otherwise well done, TJA
Prevalence

- Must always be ruled out when evaluating the painful TKA!
- Diagnosis can be difficult...
  - No gold standard single test
  - 2013 MSIS Criteria
  - AAOS Clinical Practice Guidelines

Musculoskeletal Infection Society 2013 (MSIS)

- Major Criteria:
  - A sinus tract communicating with prosthesis
  - (+) cultures from at least 2 sites surrounding prosthesis
- Minor Criteria (4 of 6 needed)
  - Elevated ESR (30 mm/hr) or CRP (10mg/L)
  - Elevated Synovial WBC (3,000 cells/μL)
  - Elevated Synovial neutrophil percentage (80%)
  - Presence of purulence
  - Positive Culture from one site surrounding prosthesis
  - > 5 neutrophils per HPS (400x magnification) frozen

AAOS CPG: Overview

- Rigorous Process
  - Evidence based
  - Systematic review of the published literature
  - Reproducible
- Work group consisted of content experts
  - Orthopaedic surgeons
  - Infectious Dz specialist, Pathologist
  - Epidemiologist
- Subject to peer review

Goal: Improve patient care based on current best evidence
**AAOS CPG Rec # 2**

Get an ESR and CRP to assess for PJI

- Inexpensive
- Ubiquitous
- High sensitivity
- Low risk to patients
- If both negative, low risk of PJI
- Excellent screening tool

**Strength: Strong!**

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**Laboratory Tests: ESR/CRP**

- ESR/CRP
  - Excellent screening tool; high sensitivity
  - Rarely normal in the face of infection
    - Schinsky, Della Valle, JBJS 2008
      - 235 consecutive revision THA's
      - No infections found in pts with nl ESR/CRP
    - Spanghel et. al, JBJS 1999
      - 202 consecutive revision THA's
      - No infections found in pts with nl ESR/CR
  - Easily obtained
  - Obtain prior to every revision TJA!

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**Joint Aspiration**

Aspirate if ESR/CRP ↑ or suspicion is high

**AAOS CPG Rec #3/4: Strength: Strong!**
Joint Aspiration

• Probably the best test
  - Ubiquitous
  - Cheap
  - Objective
• Synovial fluid WBC
  - Cut-off 1100 - 3,000/μL
• Differential: 60-80%
  - > 90% very suspicious
• Culture
  - Aerobic, Anaerobic, Fungal
  - Repeat Aspiration if Discrepancy

AAOS CPG #7: Strength: Consensus

Joint Aspiration

• Synovial fluid WBC
  - Cut-off 1100 - 3,000/μL
• Differential: 60-80%
  - > 90% very suspicious
• Culture
  - Must be off of abx for > 2 weeks prior to aspiration

AAOS CPG #8: Strength: Moderate

Nuclear Medicine Studies

• 2nd Line test
• Usually when aspirate no fluid
• ESR/CRP ↑ and/or clinical suspicion high
• Indium scans w/sulfur colloid
  - Correct for "marrow packing"
• Negative scan helpful...
  predicts the absence of infection

AAOS CPG #9: Nuclear Imaging is an option
  Strength: Weak
Intra-Operative Gram Stains

- NOT ADEQUATE!
- *Della Valle, et. al. JOA 1999*
  - Sensitivity 15%
- *Spanghel et. al, JOA 1999*
  - Sensitivity 19%
- Can also be falsely "+"
  - Crystals in dye
  - Bacteria can grow in dye!!!
  - Oelhafgen, Baeua **CORR 2011**

**CPOG #11: Against Intra-Operative Gram Stains**

Strength: Strong

Intra-Operative Frozen Sections

- Reliable if your pathologist is...
  - Subjective
  - Prone to sampling error
  - Cut-off criteria controversial
  - Good "Rule In" test

**CPOG #12: Selective Use of Intra-Op Frozen Sections**

Strength: Strong

Cultures

- Multiple cultures (odd #)
  - Aerobic
  - Anaerobic
  - AFB/Fungal?
    - Particularly if prior aspiration negative but suspicion high
- Tissue probably best

**CPOG #13: Obtain Multiple Cx; Strong**
**AAOS CPG Rec # 14**

*Don’t give abx until you make a diagnosis and get cultures from the joint!*

- Reduces risk of false negative cultures
- If you give them without making a Dx.....
- Increases confusion over diagnosis
- Makes antibiotic selection more difficult

**Strength: Strong**

**AAOS CPG Rec # 15**

*Unless suspicion is high and you don’t already have the bug, give abx prior to skin incision in revisions*

- Doesn’t seem to affect culture recovery
  - Burnett et. Al, CORR 2010
  - Moderate because only one study supports this
  - Tetreault, Parvizi, Della Valle: 2013 KS Award
  - RCT of patients with known PJI: no difference in organism recovery if abx given prior to incision

**Pre-incisional abx are a powerful weapon to prevent PJI**

**Strength: Moderate**

**So What is new??**

- UA strips for leukocyte esterase
  - Used for peritonitis and chorioamnionitis
  - Why not TJA?
Biomarkers: Alpha-Defensin
- A natural antimicrobial peptide
- Released by neutrophils to kill pathogens
- Concentrates in the synovial fluid if infected

Alpha-Defensin Data

2014 CORR
Gold-standard: MSIS criteria for PJI
95 Patients
Alpha-defensin
Sensitivity: 100%
Specificity: 100%

2014 JBJS
Gold-standard: MSIS criteria for PJI
149 Patients
Alpha-defensin
Sensitivity: 97%
Specificity: 96%

Summary
- Diagnosis can be difficult to make
  - ESR/CRP preop all revision TKA
  - Preop aspiration w/cell count and cx
- Biomarkers ????
Summary

- Major Criteria:
  - A sinus tract communicating with prosthesis
  - (+) cultures from at least 2 sites surrounding prosthesis
- Minor Criteria (4 of 6 needed)
  - Elevated ESR (30 mm/hr) or CRP (10mg/L)
  - Elevated Synovial WBC (3,000 cells/μL)
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Thank You
ANTIBIOTIC IRRIGATION IN TOTAL JOINT ARTHROPLASTY

HIGH CONCENTRATION
- Vancomycin 1000 mg/liter (1000 micrograms/ml)
- Polymyxin 250,000 units/liter
- Irrigation starts immediately and continues throughout procedure.

IV Vancomycin produces about 5 micrograms/ml, and it is transient.
And it is affected by the tourniquet

BROAD SPECTRUM
- Vancomycin: Almost all gram positives
- Polymyxin: Almost all gram negatives
KILLING POWER = AREA UNDER CURVE

PULSATILE LAVAGE:
MORE EFFECTIVE THAN BULB SYRINGE
HUGHES ET AL ORTHOPEDICS 2012

CONTINUED THROUGHOUT PROCEDURE
• Started within minutes of incision.
• Combined with constant cleaning and cooling of the saw.
• Keeps Antibiotic level high and debris level low throughout the procedure.
CONTINUED THROUGHOUT PROCEDURE

FILL MEDULLARY CANALS

- Kills bacteria that were sucked into the canal.
- Creates large reservoir that loads the joint and local lymphatics with antibiotics.
PUMP FLUID INTO SUBCUTANEOUS TISSUE DURING ENTIRE PROCEDURE.

PUMP IRRIGATION FLUID INTO SOFT TISSUES

• Penetrates tissue before bacteria can.
• Leaves antibiotic reservoir in wound.

PUMP IRRIGATION FLUID INTO SOFT TISSUES DURING CLOSURE.
PUMP FLUID INTO SUBCUTANEOUS TISSUE DURING CLOSURE.

• Kills bacteria that were ground in by retraction.
• Releases antibiotics through the skin edges to protect the incision.

KILLING POWER = AREA UNDER CURVE

THE LITERATURE IS COMPELLING!

• Lord SG&O 1983
Infection Rate in vascular surgery decreased from 5% to 0.1% with local intraoperative antibiotic irrigation.
• Bob Volz: CORR 1984
  Tissue levels in bone, tendon, muscle and subcutaneous tissues are bactericidal and remain high for 24 hours.

ASSOR: CAN J SURG: 2010
• Prospective controlled study.
• 135 TKA’s.
• Vancomycin paste applied to articular surface
• 4.1% vs 0%
• p<0.014

STROM ET AL: CLIN NEUROL AND NEUROSURG: 2013
• Vancomycin Powder at end of case decreased infection rate in instrumented spinal cases from 11% to 0%.
p=000018
MYUNG ET AL. J PEDIATR ORTHOP 2014
• >500 adolescent thoracolumbar fusions
• Retrospective with 2 variables
• 11% vs 0.7%
• p<0.001

O’NEIL ET AL. SPINE 2011
• Retrospective Review posterior spine fusions for trauma.
• 13% vs 0%
• p=0.02

GODI ET AL. J NEUROSURG SPINE 2013
• 110 trauma thoracolumbar fusions
• Prospective controlled study
• 13% vs 0%
• p=0.02
• Cost savings of $438,165 per 100 primary cases
PERSONAL EXPERIENCE
JAN 2004-DEC 2013
• 1,196 primary TKA’s
• 631 Primary THA’s
• 285 Revision TKA’s
• 181 Revision THA’s
• Surgical Time 1hr 13 min -8hr 34 min

PERSONAL EXPERIENCE
• No Acute Infections
• Three THA’s Fat Necrosis and Debridement: One Revised for Contamination of the Implants.
• One TKA with Pseudoaneurysm and Late Infection

INTRA-ARTICULAR ANTIBIOTICS IN REVISION OF INFECTED TOTAL KNEE
Debridement
Soft Tissue Mgmt
Intra-articular Antibiotics
CLASSIC TECHNIQUE
CEMENT SPACER AND IV ANTIBIOTICS

ANTIBIOTIC CONCENTRATION
Cement Spacer vs Beads
Salvati et al CORR 1984

BIOFILM WITH CEMENT SPACER PLUS ABS
VAN DE BELT: 2000
**BIOFILM WITH AB CEMENT SPACER**

Neut et al: J Antimicrobial Chemotherapy, 2001

At second stage, 18 of 20 knees had positive cultures on antibiotic-loaded cement beads

**2-STAGE REVISION WITH AB SPACER:**
**HIGH FAILURE RATE FOR CASES WITH RESISTANT BACTERIA**

Hirakawa K et al. (1998)  33%
Kilgus DJ et al. (2002)  82
Mittal Y et al. (2007)  24
Salgado CD et al. (2007)  38

**ALTERNATIVE**

- Revision With Cementless Implants
- Direct Antibiotic Infusion for 6 wks
SYNOVIAL FLUID CONC.

Lloyd et al
Am J Vet Res. 1988

Fibrous Cuff Seals Catheter

Catheters Sutured to Skin
INFUSION: NO OUTFLOW

INTRA-ARTICULAR CONCENTRATION

• Peak: 15,200 mcg/ml

• Trough: 733 mcg/ml
INFECTED TKA: MRSA CORR 2011
- Consecutive Series
- 37-96 months follow-up
- 11 women: 7 men
- Mean age 69: range 58-84

MAJOR SOFT TISSUE DEFICIENCY
INFECTED WITH BONE LOSS AND MASSIVE CEMENT

EXTENSIVE SOFT TISSUE DEBRIDEMENT
VIABLE BONE FLAPS

SOFTWARE TISSUE DEFECTS

MUSCLE FLAPS
**FLAPS**

**CLINICAL RESULTS**

• 17 knees remain free of infection after primary exchange
• 1 knee (osteomyelitis) required re-revision and sequestrectomy.
• All 18 free of infection at 3 yrs

**REVISION OF INFECTED TOTAL KNEE**

Debridement
Soft Tissue Mgmt
Intra-articular Antibiotics
REVISION OF INFECTED TOTAL KNEE

Debridement
Soft Tissue Mgmt
Intra-articular Antibiotics
RESULTS: REVISION AFTER FAILED REVISION FOR INFECTION

- 16 of 18 TKA’s successful
- One re-infected and revised again
- One failed due to soft tissue coverage, and amputated
- No known failures of fixation of implants
RE-INFECTION AFTER 2-STAGE REVISION FOR INFECTION

- Only one comparable study.
- 24 patients
- 4 amputations
- 5 fusions
- 10 chronic antibiotic suppression
- 5 continued pain
- Only 1 with well-functioning knee
Management of Bone Loss in Revision TKA Following Infection
Vumedi/ Webinar Feb 4th
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Disclosure
- Consulting and Royalties – Stryker
- AAOS Annual Meeting Committee – Hip presentations

Projected TKA Burden
Management of Bone Loss in Revision TKA Following Infection

- Infection eradicated?
- Quality of the soft tissues?
- Spacer?
- Extent of bone loss?
  - Femoral side
    - Epicondyles intact?
  - Tibial side
    - Tubercle intact?

Goals:
- Stable implant
- Restore Mechanical axis
- Balance flexion / extension gaps
- Rotational stability
- Restore joint line

AORI Classification

Austin, 2012
Classification of Bone Defects

- Engh (AORI)
- Type 1 (F1 and T1):
  - Joint line and condyles preserved
  - Generally healthy cancellous bone with small defects
  - Bone can support primary or revision components
  - Generally augments not needed

Classification of Bone Defects

- Engh (AORI)
- Type 2
  - 1 or both condyle affected (F2A/T2A if one condyle and F2B/T2B if both affected)
  - Joint line is altered
  - Will require revision components with stem +/- augments and/or bone void filling technique

Classification of Bone Defects

- Engh (AORI)
- Type 3
  - Severe bone loss
  - Condyles may be completely gone and joint line is most likely altered
  - Will require structural allograft, custom implants or metallic cones
Preoperative Planning

- **Exposure**
  - quad snip, V-Y turndown

- **Bone Loss**
  - Segmental, metaphyseal
  - PMMA, cones, sleeves, allograft

- **Implant options**
  - Extent of bone loss
  - Integrity of collaterals
    - CR, PS, TS, Hinge
62 yr male failed prior revision
Augments not sufficient to restore joint line.
Allografts in TKA

Structural integrity for loading and durability
Restore joint line – gap balancing / ligamentous function
Summary

- Treatment of Infected TKA
- Eradicate infection
- Pre-op planning
- Address:
  - Soft tissue compromise
  - Extensor mechanism
  - Bone Loss
    - PMMA, augments, cones,
    - Sleeves, allograft
Thank You