

Musculoskeletal Infection Society

30th Annual Open Scientific Meeting



**MUSCULOSKELETAL
INFECTION SOCIETY**

August 7-8, 2020

VIRTUAL MEETING

Please join us!

31st Annual Open Scientific Meeting
of the
Musculoskeletal Infection Society



MUSCULOSKELETAL
INFECTION SOCIETY

August 6-7, 2021

Fort Lauderdale, Florida

Marriott Harbor Beach Resort and Spa

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for updates

Overview

This scientific meeting will address new research, clinical advances, diagnostic methodologies, treatment approaches and protocols being developed to care for patients with infections of the musculoskeletal system.

Objectives

At the conclusion of this educational activity, participants will:

- Understand the evolving role of biomarkers and new techniques in the microbiologic diagnosis of periprosthetic infections;
- Understand the evolving variety of local antibiotic delivery systems for use in treating musculoskeletal infections;
- Understand basic science technology as it relates to clinically important issues in biofilm formation and disruption;
- Have an enhanced understanding of the relationship between opioid use disorder and musculoskeletal infection.

Intended Audience

This course is designed for member and nonmember physicians including orthopaedic surgeons, infectious disease specialists and other health care providers who manage the care of patients with musculoskeletal infections.

Continuing Education Credit

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American Academy of Orthopaedic Surgeons and the Musculoskeletal Infection Society. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

The American Academy of Orthopaedic Surgeons designates this Other activity, MSIS 30th Annual Open Scientific Virtual Meeting, for a maximum of 6.5 *AMA PRA Category 1 Credits™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

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MUSCULOSKELETAL
INFECTION SOCIETY

30th Annual Open Scientific Virtual Meeting

August 7-8, 2020

Agenda

**All abstract presentations, Podium and Poster, will be available to view at anytime
August 1, 2020-August 8, 2020**

Symposiums will open and close at the time indicated.

**All presenting authors will be in attendance at the “Questions and Answers” Sessions
indicated.**

FRIDAY AUGUST 7, 2020

SYMPOSIUM #1

6:00pm-7:00pmCDT

**“New Approaches to the Diagnosis and Management of
Periprosthetic Joint Infection (PJI) of the Shoulder**

Moderator: Eric Ricchetti, MD

Eric Ricchetti, MD
Orthopaedic Surgeon
Cleveland Clinic
Cleveland, OH

Grant Garrigues, MD
Orthopaedic Surgeon
Midwest Orthopaedics at Rush
Chicago, IL

Jason Hsu, MD
Orthopaedic Surgeon
University of Washington
Seattle, WA

Surena Namdari, MD
Orthopaedic Surgeon
Thomas Jefferson University/Rothman Institute
Philadelphia, PA

SESSION I

7:15pm-8:20pmCDT

Introduction, Carlos Higuera Rueda, MD

CLINICAL RESEARCH I “Questions and Answers”

Moderators: Antonia F. Chen, MD/MBA; Barry Brause, MD

6: The routine use of synovial alpha-defensin is not necessary

Derek Amanatullah, Robin Cheng, James Huddleston, William Maloney, Shanthi Kappagoda, Gina Suh, Stuart Goodman

10: The Surgical Treatment of Deep Infection in the Native Shoulder Joint

Tyler Henry, Michael Gutman, Amy Backal, Surena Namdari

19: Early versus late rotational gastrocnemius reconstruction for total knee arthroplasty infections

Herrick Siegel, Matthew Hess, Jason Gay, Jeffrey Pearson

21: Stage 2 reimplantation for prior infected hip and knee arthroplasties with normal CRP and elevated ESR

Herrick Siegel, Kevin Wall, Matthew Hess, Jason Gay

23: Are Intraoperative Cultures Necessary if the Aspiration Culture is Positive? A Concordance Study in Periprosthetic Joint Infection

K. Keely Boyle, Milan Kapadia, Michael Henry, Andy Miller, Alberto Carli

24: Periprosthetic Joint Infection after Primary TKA in the Medicare Population: How Frequently are Patients Revised at a Different Hospital?

K. Keely Boyle, David Landy, Brian Chalmers, Andy Miller, Michael Cross, Milan Kapadia

25: Direct Anterior Approach to the Hip Does not Increase the Risk for Subsequent Periprosthetic Joint Infection

Noam Shohat, Karan Goswami, Timothy Tan, Leigham Breckenridge, D'Andrew Gursay, Samuel Clarkson, Javad Parvizi

27: Elevated Fructosamine Levels are Associated with Increased Risk for Periprosthetic Joint Infection Following Total Hip Arthroplasty: A Prospective Multi-center Study

Noam Shohat, Karan Goswami, D'Andrew Gursay, Leigham Breckenridge, Ran Schwarzkopf, Javad Parvizi

29: Laminar Air Flow Does Not Have a Protective Effect on the Rate of Periprosthetic Joint Infection After Primary Total Joint Arthroplasty

Samuel Clarkson, Timothy Tan, Samuel Clarkson, Karan Goswami, Javad Parvizi

30: Predictive modeling with Next generation sequencing: a Validated Multi-Institutional Adjunct for Diagnosis of Periprosthetic Joint Infection

Samuel Clarkson, Karam Goswami, Douglas Dennis, Brian Klatt, Nitin Goyal, Eric Smith, Christopher Pelt, Arthur Malkani, Jon Minter, Michael Cross, Hernan Prieto, Gwo-Chin Lee, Erik Hansen, Carlos Higuera Rueda, Craig Della Valle, Javad Parvizi

31: Reinfection or Persistence of Periprosthetic Joint Infection? Next generation sequencing Reveals New Findings

Samuel Clarkson, Karan Goswami, Douglas Dennis, Brian Klatt, Nitin Goyal, Eric Smith, Christopher Pelt, Arthur Malkani, Jon Minter, Michael Cross, Hernan Prieto, Gwo-Chin Lee, Erik Hansen, Carlos Higuera Rueda, Craig Della Valle, Javad Parvizi

32: Who Will Fail Following Irrigation and Debridement for Periprosthetic Joint Infection: A Machine Learning Based Validated Tool

Noam Shohat, Karan Goswami, Timothy Tan, Michael Yayac, Alex Soriano, Ricardo Sousa, Marjan Wouthuyzen-Bakker, Javad Parvizi

34: Hepatitis C Patients have Higher Risk of Revisions after TJA

Emanuele Chisari, Christopher Gardner, Javad Parvizi

36: Inflammatory Bowel Diseases Increases the Risk of Periprosthetic Joint Infection

Emanuele Chisari, Darran D'Mello, Javad Parvizi

37: Organism Profile Causing Periprosthetic Joint Infection: The List is Growing

Santiago Restrepo, Hannah Groff, Karan Goswami, Emanuele Chisari, Javad Parvizi

40: Calprotectin Lateral Flow Test: A Potential Rule Out Test for Periprosthetic Joint Infection

Carlos Higuera Rueda, Jared Warren, Hiba Anis, Kathy Bowers, Tejbir Pannu, Jesus Villa, Alison Klika, Jessica Colon-Franco, Nicolas Piuizzi

46: Rotational gluteus maximus flap with reimplantation of hip arthroplasty in patients that have prior resection arthroplasty

Herrick Siegel, Mattherw Hess, Christopher Odom, Kevin Wall

47: Resection Arthroplasty for Periprosthetic Joint Infection Following Total Hip or Knee Arthroplasty is Associated with High Attrition Rate and Mortality

Jesse Otero, Cameron Barton, David Wang, Qiang An, Timothy Brown, John Callaghan

51: Extended Oral Antibiotics Prevent PJI in High-Risk Cases: 3,862 Patients with 1-Year Follow-Up

Michael Kheir, Julian Dilley, Mary Ziemba-Davis, R. Michael Meneghini

73: Diagnostic Value of D-Dimer for Periprosthetic Shoulder Infection
Benjamin Zmistowski, Thema Nicholson, Surena Namdari

MSIS

BUSINESS MEETING

8:30pm-9:00pm CDT MSIS Members Only

SATURDAY AUGUST 8, 2020

SYMPOSIUM #2

9:00am-10:00amCDT **“Exploring the Unique Benefits of Using Bacteriophages to Treat
MSK Infections from the Bench to the Bedside”**

Moderator: Hesham Abdelbary

Hesham Abdelbary, MD
Orthopaedic Surgeon
University of Ottawa
Ottawa, Canada

Cynthia Barbosa da Silveira, PhD
Biologist
University of Miami
Miami, FL

Gina Suh, MD
Infectious Disease Physician
Mayo Clinic
Rochester, MN

Eddie Schwarz, PhD
Scientist
University of Rochester Medical Center
Rochester, NY

SESSION II

10:15am-11:05amCDT **Introduction, Carlos Higuera Rueda, MD**
BASIC SCIENCE “Questions and Answers”
Moderators: Alex C. McLaren, MD; Laura Certain MD

5: A Novel Activated-Zinc Antiseptic Solution Effective Against *Staphylococcus aureus* and *Pseudomonas aeruginosa* in a Pig Model

Derek Hill, Cody Pinger, Erica Noland, Kevin Morton, Alessandra Agostinho Hunt, Elizabeth Pensler, Sarah Cantu, Paul Attar, Ahmed Siddiqi

7: *Staphylococcus aureus* initially and preferentially utilizes biofilm mediated tolerance prior to antibiotic resistance

Derek Amanatullah, Robert Manasherob, Jake Mooney, David Lowenberg, Paul Bollyky

8: *Staphylococcus epidermidis* Biofilms Have a High Tolerance to Antibiotics in Periprosthetic Joint Infection

John Koch, Taylor Pust, Alex Cappellini, Jonathan Mandell, Dongzhu Ma, Neel Shah, Kimberly Brothers, Kenneth Urish,

11: The *Staphylococcus aureus* Toxin-Antitoxin system YefM-YoeB is associated with extracellular dependent antibiotic tolerance and biofilm formation

Kimberly Brothers, Dongzhu Ma, Kenneth Urish

12: Sub-MIC vancomycin promotes *Staphylococcus aureus* biofilm formation, infection, and pathogenesis.

Kenneth Urish, Masashi Taguchi, Kimberly Brothers, Lance Thurlow, Dongzhu Ma

15: Differences between Acute and Chronic Periprosthetic Joint Infection in a Mouse Model; Transition from an acute to chronic infection start at an early time period.

Masashi Taguchi, Shinsuke Kihara, Peter Mittwede, Kimberly Brothers, Freddie Fu, Kenneth Urish

17: Direct antimicrobial activity of WLBU2 against *S. aureus* biofilms is enhanced in physiologic buffered saline

Jonathan Mandell, John Koch, Kenneth Urish

18: A distinctive release profile of vancomycin and tobramycin from a new and injectable polymeric dicalcium phosphate dehydrate cement (P-DCPD)

Emily Ren, Weiping Ren, Rahul Vaidya, Paul Begeman, Angelica Guardia

26: Efficacy of Various Surgical Irrigation Solutions Against Established Biofilm: A Comparative *in vitro* Investigation

Jeongeun Cho, Karan Goswami, Kamolsak Sukhonthamarn, Javad Parvizi, William Arnold

33: Inhibition of Angiotensin Converting Enzyme Impairs Anti-*Staphylococcal* Immune Function in a Preclinical Model of Implant Infection

Rishi Trikha, Danielle Greig, Benjamin Kelley, Zeinab Mamouei, Troy Sekimura, Nicolas Cevallos, Nicholas Bernthal

49: Local Antibiotic Delivery via Calcium Sulfate for Orthopaedic Infections

Daniel Driscoll, Kathleen Turajane, Ajay Premkumar, Xu Yang, Andy Miller, Mathias Bostrom, David Wellman, Ashley Levack, Alberto Carli

50: Thermal Stability and In Vitro Elution Kinetics of Alternative Antibiotics when used in Polymethylmethacrylate (PMMA) Bone Cement

Alberto Carli, Kathleen Turajane, Xu Yang, Andy Miller, Mathias Bostrom, David Wellman, Ashley Levack

77: Polymicrobial Synergy: *Staphylococcus aureus* - *Candida albicans* Coinfection Increases Colonization and Antibiotic Resistance

Zeinab Mamouei, Benjamin Kelley, Nicolas Cevallos, Ameen Chaudry, Nicholas Bernthal

78: In Vitro Analysis of Anti-Biofilm Effect of Intraoperative Irrigation Solutions

Ajay Premkumar, Sita Nishtala, Mathias Bostrom, Alberto Carli

92: Spatial distributions of cytokines in chronic localized infections

Taylor Shackleford, Nicole Prince, Jonathan Boyd, Julia Penatzer, Matthew Dietz

111: Minimum Biofilm Eradication Concentration of Caspofungin against *Candida* and *Aspergillus*

Jessica Burns, Rex Moore, Paulo Castaneda, Derek Overstreet, Alex McLaren

10:55am-11:30am CDT BREAK

SYMPOSIUM #3

11:30am-12:30pmCDT

“Extended Use of Antibiotics for Prophylaxis and Treatment after Orthopaedic Surgery”

Moderator: Thorsten Seyler, MD

Gregory Della Rocca, MD, PhD

Associate Professor

University of Missouri School of Medicine

Columbia, MO

Jessica Seidelman, MD

Infectious Disease Physician

Duke University School of Medicine

Durham, NC

Thorsten Seyler, MD, PhD

Orthopaedic Surgeon

Duke University School of Medicine

Durham, NC



SESSION III

12:45pm-1:50pmCDT

Introduction, Carlos Higuera Rueda, MD

CLINICAL RESEARCH II “Questions and Answers”

Moderator: Brian Klatt, MD; Gina Suh, MD

53: The CRIME80 Predicts Failure of Debridement, Antibiotics, and Implant Retention (DAIR) for Total Hip and Knee Arthroplasty Acute Hematogenous Periprosthetic Joint Infection

Brian Chalmers, Milan Kapadia, Y-fen Chiu, Andy Miller, Michael Henry, Alberto Carli

54: The KLIC Did Not Predict Failure of Debridement, Antibiotics, and Implant Retention (DAIR) for Total Hip and Knee Arthroplasty Acute Postoperative Periprosthetic Joint Infection

Brian Chalmers, Milan Kapadia, Yu-fen Chiu, Andy Miller, Michael Henry, Alberto Carli

55: Results of Irrigation and Debridement for PJI with the Use of Intraosseous Antibiotics
Beau Kildow, Shaun Patel, Jesse Otero, Keith Fehring, Brian Curtin, Bryan Springer, Thomas Fehring

58: Deep infection after distal radius open-reduction internal fixation.

Tyler Henry, Richard McEntee, Jonas Matzon, Pedro Beredjikian, Kevin Lutsky

59: Infection Rates Associated with Immediate Use Steam Sterilization

Alex Demers, Thomas Moran, Joseph Park

60: Does performing total joint arthroplasty in the afternoon or evening increase the risk of prosthetic joint infection?

Ibrahim Tuncay, Orkhan Aliyev

64: Antibiotic Stewardship Interventions Significantly Improve Preferred Antibiotic Prophylaxis in Elective Primary Total Joint Arthroplasty

Raquel Roberts, Katelyn Quartuccio, Jessica Stern, Eric Heintz, Kelly Pillinger, Thomas Myers

66: KLIC and CRIME80 Do Not Predict DAIR Success for PJI

Christine Wu, Sean Ryan, Zoe Hinton, William Jiranek, Jessica Seidelman, Thorsten Seyler

67: ED Utilization in TJA: Analysis of PICC Readmissions

Zoe Hinton, Sean Ryan, Christine Wu, Jessica Seidelman, William Jiranek, Thorsten Seyler

69: Decreased 90-Day Surgical Site Complication Rates with Closed Incision Negative Pressure Therapy after Revision Knee Arthroplasty: A Randomized Trial

Ahmed Emara, Herbert Cooper, Michael Cross, George Guild, Denis Nam, Giles Scuderi, Fred Cushner, Ronald Silverman, Carlos Higuera Rueda

70: High Rate of Infection Associated with Arthroscopic Lysis of Adhesions for Arthrofibrosis following Total Knee Arthroplasty
Nathan Thomas, Christina Liu, Nathan Varady, Pierre-Emmanuel Schwab, Yhan Colon Iban, Antonia Chen

71: Lower Socioeconomic Status is Associated with Increased Risk of Girdlestone Resection Arthroplasty Following Periprosthetic Infection of the Hip
Gregory Kirchner, Alexander Lieber, Yehuda Kerbel, Raymond Kim, Vincent Moretti, Lucas Nikkel

75: Surprising Little Impact of Obesity on Outcomes Following 2 Stage Reimplantation Total Knee Arthroplasty for Infection
Yehuda Kerbel, Joseph Koressel, Brian Perez, Ryan DeAngelis, Gwo-Chin Lee

76: Increasing Complications and Failures with Increasing BMI in Patients Undergoing 2-Stage Exchange for Infected THA
Yehuda Kerbel, Nicolas Pascual-Leone, Ariana Meltzer-Bruhn, Matthew Stein, Gregory Kirchner, Gwo-Chin Lee

80: ASA after total hip and knee arthroplasty can significantly reduce post operative persistent wound drainage
Alisina Shahi, Alec Kellish, Vishavpreet Singh, Ali Oliashirazi

84: Plasma D-Dimer Does Not Determine the Fate of Reimplantation in Two-Stage Exchange Arthroplasty
Tejbir Pannu, Jesus Villa, Charles Engh III, Brett Levine, Jorge Manrique, Nicolas Piuizzi, Aldo Riesgo, Carlos Higuera Rueda

85: Impact of joint type on time to aspiration and targeted antibiotic administration in patients with septic arthritis
Edward Woods III, Anne Sullivan

86: Outcomes of Knee Endofusion for Prosthetic Joint Infection
Alexandra Stavrakis, Sai Devana, Madhav Chowdhry, Edward McPherson, Matthew Dipane

87: Outcomes of Patients Undergoing Second Stage Reimplantation following Knee Endofusion for PJI
Alexandra Stavrakis, Sai Devana, Madhav Chowdhry, Edward McPherson, Matthew Dipane

89: Compressive Osseointegration Device for Management of Previously Infected, Non-Oncologic Salvage Arthroplasty
Scott Galey, James Chen, Shannon Wu, Mahdavi Chowdhry, Matthew Dipane, Nicholas Bernthal, Adam Sassoon, Edward McPherson

99: A dry aspiration prior to reimplantation arthroplasty should not be considered reassuring

Joseph Karam, Steven Yacovelli, Matthew Grosso, Javad Parvizi

105: Risk Factors Associated With Developing Surgical Site Infections or Peri-Prosthetic Joint Infections Following Primary Total Hip Arthroplasty for Acetabular Fractures

Rushabh Vakharia, Matthew Ciminero, Angelo Mannino, Asad Ashraf, Michael Mont, Kevin Kang

106: Transverse Posterior Wall Acetabular Fractures Undergoing Conversion Total Hip Arthroplasty are at High-Risk of Periprosthetic Joint Infection

Kyle Cichos, Clay Spitler, Gerald McGwin Jr, Elie Ghanem

1:50pm-2:15pmCDT

Closing remarks, New President Introduction

Carlos Higuera Rueda, MD

Angela Hewlett, MD

Symposium #1

New Approaches to the Diagnosis and Management of Periprosthetic Joint Infection (PJI) of the Shoulder

Moderator: Eric Ricchetti, MD

Eric Ricchetti, MD
Orthopaedic Surgeon
Cleveland Clinic
Cleveland, OH

Grant Garrigues, MD
Orthopaedic Surgeon
Midwest Orthopaedics at Rush
Chicago, IL

Jason Hsu, MD
Orthopaedic Surgeon
University of Washington
Seattle, WA

Surena Namdari, MD
Orthopaedic Surgeon
Thomas Jefferson University/Rothman Institute
Philadelphia, PA

Session I

Clinical Research

Moderators: Antonia F. Chen, MD/MBA; Barry D. Brause, MD

ID: 3**Single versus Two Stage revision for Prosthetic Joint Infection – Minimum two year Results**

Nemandra Sandiford, Daniel Kendoff

Background / Rationale: The optimal treatment of prosthetic Joint Infection(PJI) is unclear. Two stage revision is the gold standard. This technique requires 2 separate procedures with a potentially higher risk of surgical morbidity. Single stage revision has gained popularity. Equivalent results have been reported with this technique. Relatively few studies have compared the results of these techniques from the same centre.

Study Question: The aim of this study is to compare the results of single and 2 stage revisions from a single unit.

Methods: A retrospective study was performed. All patients undergoing revision procedures for a diagnosis of PJI between 2012 and 2017 were included. Patient demographics, surgical procedure and all complications were recorded. Failure was defined as recurrence of infection or occurrence of a new infection.

Statistical analysis was performed using the unpaired students t-test.

Results: Sixty patients underwent 61 single stage revisions . Thirty two two stage revisions were included.

The mean age of patients undergoing single stage revision was 68.2 years versus 66.3 years for those receiving two stage revisions. Patients were followed up for an average of 43.2 and 30 months in the single and 2 stage groups respectively. Average Charlson score was 3.3 in the single stage group and 2.9 in the two stage group($p=0.31$).

Infection eradication was successful in 81.9% following single stage revisions compared with 62.5% in the two stage group($p=0.64$).

In the single stage group PJI involving the hip and knee were eradicated in 80.0% and 85.7%, respectively ($p=0.06$).

In the 2 stage group PJI involving the hip and knee were eradicated in 73.9% and 33.3% respectively ($p=0.08$).

In the hip group infection was eradicated in 80.0% of single stage revisions vs 73.9% of two stage revisions ($p=0.09$). In the knee PJI group eradication occurred in (85.7%) in the single stage group compared to (33.3%) in the 2 stage group ($p=0.06$).

Single stage procedures were performed 9.3 months earlier than two-stage revisions from the presentation of infection (mean time from presentation to operation 4.9 months single-stage, 14.2 months two-stage, $p=0.03$).

Discussion: For hip PJI single stage revision was comparable to two stage revision. Single stage revision for knee PJI was more successful than two stage revision. This was not statistically significant.

Conclusion: Single stage revision is not inferior to 2 stage revision for PJI.

ID: 6

The routine use of synovial alpha-defensin is not necessary

Derek Amanatullah, Robin Cheng, James Huddleston, William Maloney, Shanthi Kappagoda, Gina Suh, Stuart Goodman

Background / Rationale: The laboratory-based synovial alpha-defensin immunoassay is highly sensitive and specific for PJI, its pragmatic clinical utility needs to be defined.

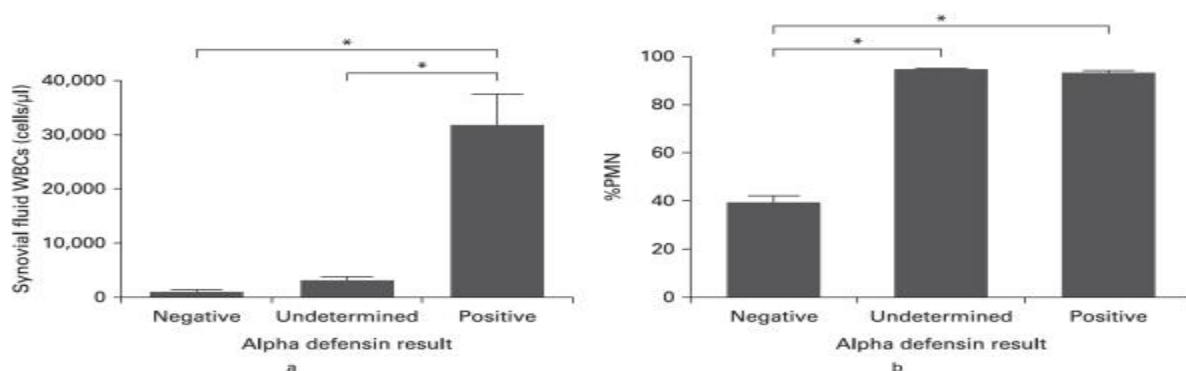
Study Question: Does adding alpha-defensin testing to the traditional PJI work-up affect clinical decision making?

Methods: Four physicians evaluated 158 consecutive patients being worked up for PJI (94 underwent revision). After randomization, each physician decided on the presence of PJI according to the 2014 MSIS criteria (yes, no, or undetermined) with and without the alpha-defensin result. Alpha-defensin was correlated to the synovial aspiration (WBC and PMN%). Comparisons were made with ICC, ANOVA, as well as multilevel logistic regression. Nonoverlapping confidence intervals (CI) and $p < 0.05$ were considered statistically significant.

Results: Intra- and interobserver agreement did not change when the alpha-defensin was available. A positive alpha-defensin had greater synovial WBCs (31854 ± 32594 cells/ μ L, Figure 1A) and %PMN ($93 \pm 6\%$, Figure 1B) than negative alpha-defensin (974 ± 3988 cells/ μ L; $p < 0.001$ and $39 \pm 29\%$; $p < 0.001$). Adding alpha-defensin did not alter the diagnosis using pre-operative (OR 0.52, CI 0.14-1.88; $p = 0.315$) or operative (OR 0.52, CI 0.18-1.55; $p = 0.242$) data. However, when undetermined, alpha-defensin helped diagnose (OR 0.44, CI 0.30-0.64; $p < 0.001$) or rule out (OR 0.41, CI 0.17-0.98; $p = 0.044$) PJI. Of the 27 undecided cases, 24 (89%) benefited from the addition of alpha-defensin.

Discussion: Alpha-defensin did not substantially change a provider's ability to diagnose or rule out PJI when added to routine testing. Alpha-defensin simply mimicked the cut-offs already established for synovial WBCs and %PMN. This suggests the routine incorporation of alpha-defensin testing to diagnose PJI was unnecessary. It should be noted that this redundancy, in the context of the 2018 MSIS minor criteria, effectively elevates alpha-defensin to a major criterion. Our data call into question the weighting of the 2018 MSIS minor criteria. Alpha-defensin testing did influence clinical decision making when applied to cases in which the provider was uncertain regarding presence of PJI

Conclusion: We recommend against the routine use of alpha-defensin and suggest using it only when traditional testing is indeterminate.



ID: 19

Early versus late rotational gastrocnemius reconstruction for total knee arthroplasty infections

Herrick Siegel, Matthew Hess, Jason Gay, Jeffrey Pearson

Background / Rationale: Medial gastrocnemius rotational flaps may be very helpful to provide adequate soft tissue coverage around the knee region in patients with total knee arthroplasty infections. The optimal timing regarding when these flaps should be performed is often uncertain. This study evaluates the functional outcome of patients treated with medial gastroc flaps before and after a stage 2 revision procedure.

Study Question: Does the timing of when a rotational flap is performed impact the functional and treatment outcome of total knee infected patients with anterior sinus tracts?

Methods: Between 2007 and 2014, 42 patients were identified that were treated with medial gastrocnemius flaps for infected knee arthroplasty. 24 of these patients had a flap performed at the time of the stage 1 procedure and 18 at the time of the stage 2. Data regarding functional and infection treatment outcome with a minimum of 2 year follow up was collected retrospectively. Complications associated with treatment were also recorded as well as whether patients required narcotics for pain control at 2 years follow up.

Results: Of the 42 patients included, all were able to be examined and interviewed at 2 year follow up. 22 of 24 patients treated with a flap at the stage 1 procedure were infection free and off narcotic medication. 13 of 18 patients treated with a flap at stage 2 were infection free and only 9 were no longer taking narcotic at 2 years follow up. Functional outcome based on KOOS instrument were superior in flaps performed at the stage 1 procedure.

Discussion: Early rotational flap coverage is superior to delayed coverage. Elevation of the flap at the stage 2 procedure is recommended. Successful outcome in terms of function and infection control can be achieved in over 90% of patients with anterior sinus tracts. Additionally, it is believed that the rotational flap is protective of the extensor mechanism which is highly vulnerable to rupture in these complex cases.

Conclusion: Based on our findings with a minimum of 2 years of follow up, early referral to a specialist with training in rotational flap coverage should be done when sinus tracts develop. While prospective studies should be performed, rotational flap procedures training should be a part of a total joint fellowship.

Stage 2 reimplantation for prior infected hip and knee arthroplasties with normal CRP and elevated ESR

Herrick Siegel, Kevin Wall, Matthew Hess, Jason Gay

Background / Rationale: CRP and ESR are commonly used serum markers to determine infection control of periprosthetic joint infections. Aspiration is an essential part of the evaluation for treatment affect; however there are limitations. False negatives, and false positives may result for poor aspiration technique and at times insufficient fluid can be found for testing. CRP and ESR are heavily relied up when deciding whether to proceed with reimplantation of joint implants.

Study Question: Is a normal CRP sufficient to proceed with a stage 2 reimplantation if the ESR remains consistently elevated? Is there a long term impact on treatment outcome if the ESR remains elevated?

Methods: Between 2011 and 2015, 211 patients were treated with 2 stage reconstructions with a minimum follow up of 1 year. Of the 211 patients, 77 of these patients had an abnormal ESR at the time of reimplantation and a normal CRP. The remainder of the patients had normal CRP and ESR. These 2 groups were compared in terms of infection control as determined by infection disease clinical reports. Follow up ranged from 1 to 4 years.

Results: Of the 211, 19 were treated for recurrent infection of the same treated joint. Of these 19, only 4 had elevated ESR at the time of reimplantation, the remainder of the recurrent infections were seen in patients with normal CRP and ESR. Of the 19 recurrent infections, 15 were seen in total knees and 4 n total hips. Those patients with elevated ESR at the time of reimplantation were noted to have an earlier reinfection than the normal ESR group; however, no statistically significant difference was seen between those with elevated compared to normal ESR at the time of reimplantation.

Discussion: ESR may be influenced by many variables and is poor predictor of infection control prior to reimplantation. Our study did not show a difference between the infection control of those patients reimplanted with a normal CRP and elevated ESR compared with normal CRP and normal ESR. CRP remains an important indicator of sufficient infection control however ESR is less reliable.

Conclusion: CRP is a good indicator of adequate infection control in periprosthetic joint infection independent of ESR. ESR may be elevated by other patient co-morbidities and variables and is not a reliable indicator for timing of stage 2 reimplantation for hip and knee arthroplasty.

Are Intraoperative Cultures Necessary if the Aspiration Culture is Positive? A Concordance Study in Periprosthetic Joint Infection

K.Keely Boyle, Milan Kapadia, Michael Henry, Andy Miller, Alberto Carli

Background / Rationale: Despite known differences in diagnostic utility, it remains unknown if preoperative synovial fluid culture is equivalent to multiple intraoperative tissue cultures for identifying relevant causative organisms in PJI.

Study Question: Our aim was to determine the prevalence of discordance between synovial fluid and tissue culture, prevalence of polymicrobial infection detection, and antibiotic susceptibility patterns among discordant cultures.

Results: Concordance was identified in 274 (84.0%) patients with similar rates among THAs (85.2%) and TKAs (82.8%; χ^2 0.351, $p=0.55$). Culture discordance occurred in 52 (16%) patients; 34 (10.4%) in the discordant-similar group and 18 (5.6%) in the discordant-different group. There were a significantly greater proportion of discordant-different results in THAs (52%) compared to TKAs (18.5%; χ^2 6.43, $p=0.01$). MRSA demonstrated the highest concordance rate (95.0%; 20 of 21), while *C. acnes* demonstrated the lowest (52.9%; 9 of 17). Within the discordant-similar group, *S. epidermidis* and *C. acnes* most commonly were co-infecting organisms at revision surgery. Enterococcus species (22.2%) most commonly grew independently from aspiration and became polymicrobial on tissue culture in the discordant-different group.

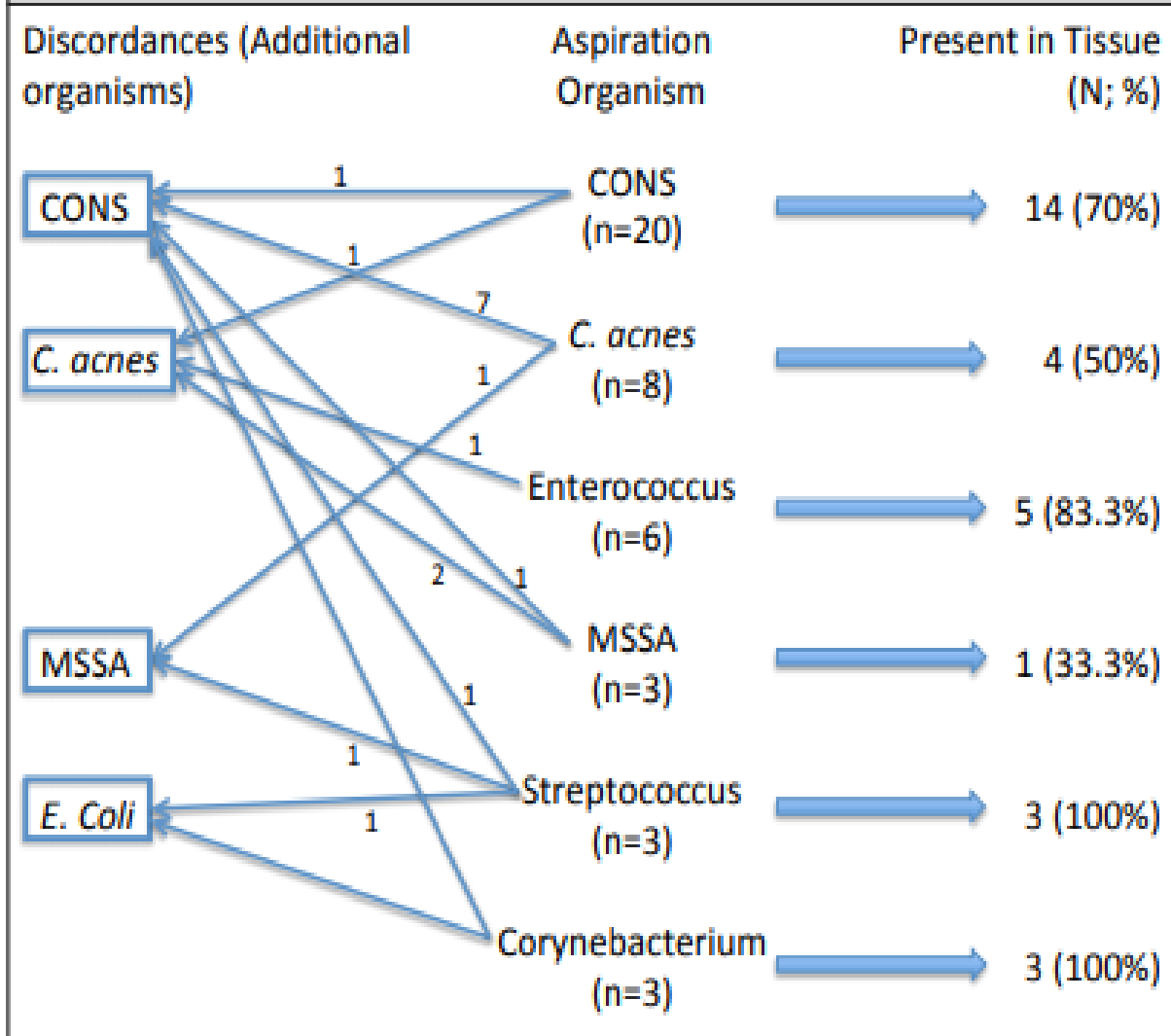
Methods: A total of 326 patients (169 hips, 157 knees) who met MSIS diagnostic criteria for PJI following primary TJA were identified from a longitudinally maintained PJI database. Inclusion criteria required a positive preoperative intra-articular synovial fluid and intraoperative tissue culture(s) at time of revision surgery. Patients were divided into two categories; concordant and discordant. Discordant cultures were further subcategorized into 'similar' and 'different' according to antibiotic sensitivities.

Results: Concordance was identified in 274 (84.0%) patients with similar rates among THAs (85.2%) and TKAs (82.8%; χ^2 0.351, $p=0.55$). Culture discordance occurred in 52 (16%) patients; 34 (10.4%) in the discordant-similar group and 18 (5.6%) in the discordant-different group. There were a significantly greater proportion of discordant-different results in THAs (52%) compared to TKAs (18.5%; χ^2 6.43, $p=0.01$). MRSA demonstrated the highest concordance rate (95.0%; 20 of 21), while *C. acnes* demonstrated the lowest (52.9%; 9 of 17). Within the discordant-similar group, *S. epidermidis* and *C. acnes* most commonly were co-infecting organisms at revision surgery. Enterococcus species (22.2%) most commonly grew independently from aspiration and became polymicrobial on tissue culture in the discordant-different group.

Discussion: Clinicians treating PJI should consider collecting both aspiration and tissue cultures for accurate pathogen identification, especially if the aspiration culture is positive for a low virulence organism (*C. acnes*) or for enterococci. Conversely, aspiration cultures positive for MRSA have a very high rate (95%) of monomicrobial tissue culture concordance and clinicians should feel comfortable commencing antibiotic therapy and planning revision surgery in these cases.

Conclusion: The majority of aspiration and tissue cultures in culture positive PJI are concordant, but this concordance varies based on bacterial species.

Figure 1. Microbiology of Most Common Culture Discordant Aspirations Compared to Intraoperative Tissue Culture Results



Periprosthetic Joint Infection after Primary TKA in the Medicare Population: How Frequently are Patients Revised at a Different Hospital?

K.Keely Boyle, David Landy, Brian Chalmers, Andy Miller, Michael Cross, Milan Kapadia

Background / Rationale: Periprosthetic infection after total knee arthroplasty places a significant burden on hospitals. There is sparse literature evaluating whether PJI TKA patients who seek care at different institutions move towards or away from larger-volume TJA centers. Determining characteristics of the hospital where patients are being treated for postoperative TKA PJIs will shed light on these healthcare dynamics and guide care quality assessment, resource utilization and cost-effectiveness.

Study Question: We sought to describe the proportion of patients undergoing revision for PJI at a different hospital within one year of primary TKA and whether patient characteristics or hospital volume were associated with this change.

Methods: Medicare data from 2005 to 2014 was retrospectively reviewed using PearlDiver. All patients over 64 years undergoing revision for PJI within one year of primary TKA were stratified by the revision occurring within 90 days. Hospitals were grouped by annual TKA volume as Low (<50), Medium (51-100), High (101-200), and Very High (>200). Associations of patient characteristics and hospital volume with revision at a different hospital were assessed using Chi-squared tests and Somers's D.

Results: Of 8,337 patients undergoing revision within 90 days of TKA, 1,370 (16%) were revised at a different hospital. Changing hospitals was associated with having primary TKA at a lower volume hospital (24% for low, 15% medium, 12% high, and 12% very high; $P<.001$). Of 7,608 patients undergoing revision between 91 and 365 days, 1,110 (15%) were revised at a different hospital. Changing hospitals was associated with having primary TKA at a lower volume hospital (26% for low, 14% medium, 10% high, and 9% very high; $P<.001$). Changing hospitals was not associated with sex or age.

Discussion: Patients frequently undergo revision for PJI within 1 year of TKA at a different hospital. Even within 90 days, up to 1 in 6 patients change hospitals. While patients from low volume hospitals are more likely to undergo revision at a different hospital, this is common across all hospital volume groups. When patients change hospitals for their revision, those from low volume hospitals tend to go to higher volume hospitals while those from higher volume hospitals often go to lower volume hospitals.

Conclusion: Patients frequently undergo revision for PJI at a different hospital, even within 90 days of TKA.

Table 1: Characteristics of patients undergoing surgical management of PJI by interval from index arthroplasty

Characteristic	PJI Revision	
	Within 90 days N=8,837 N (%)	Between 91 to 365 days N=7608 N (%)
Sex		
Female	4,716 (53%)	3,760 (49%)
Male	4,121 (47%)	3,848 (51%)
Age		
65 to 69 years	2,914 (33%)	2,379 (31%)
70 to 74 years	2,439 (28%)	2,190 (29%)
75 to 79 years	1,856 (21%)	1,699 (22%)
80 to 84 years	1,152 (13%)	908 (12%)
85 years or older	476 (5%)	432 (6%)
ECI		
0-5	2,140 (24%)	1,755 (23%)
6-12	4,781 (54%)	4,118 (54%)
13 or great	1,916 (22%)	1,735 (23%)
Region		
Northeast	1,347 (15%)	1,192 (16%)
South	3,571 (40%)	3,089 (41%)
Midwest	2,375 (27%)	2,053 (27%)
West	1,544 (17%)	1,274 (17%)
Hospital volume		
Low	1,512 (17%)	1,266 (17%)
Medium	4327 (49%)	3,673 (48%)
High	2,107 (24%)	1,879 (25%)
Very High	891 (10%)	790 (10%)

Direct Anterior Approach to the Hip Does not Increase the Risk for Subsequent Periprosthetic Joint Infection

Noam Shohat, Karan Goswami, Timothy Tan, Leigham Breckenridge, D'Andrew Gursay, Samuel Clarkson, Javad Parvizi

Background / Rationale: It remains controversial whether surgical approach is associated with subsequent periprosthetic joint infection (PJI) following primary total hip arthroplasty (THA).

Study Question: The aim of this study was to compare PJI rates following direct anterior (DA) and direct lateral (DL) approaches, accounting for changes in practice made in recent years to reduce rates of PJI.

Methods: We identified 9,416 consecutive primary THA performed by four surgeons between 2006-2016 at a single academic center. Data on demographics and comorbidities were extracted. Over the course of the study period, several stepwise measures were implemented to reduce rates of PJI, including use of dilute povidone-iodine irrigation, skin closure with subcuticular monofilament suture, and application of an occlusive dressing. PJI was defined based on the 2018 criteria. Univariate analysis followed by multivariate regression accounting for various confounders was performed.

Results: During the period studied, there were 3,959 DA and 5,457 DL primary THA performed. There was no significant association between approach and PJI in the univariate analysis. The PJI rate was 0.5% for the DA group and 0.6% for the DL group ($p=0.265$). In a regression analysis accounting for: body mass index (95%CI 0.99-1.10), Charlson comorbidity index (95%CI 1.08-1.49), operative time (95%CI 1.003-1.017), general vs. spinal anesthesia (95%CI 1.45-7.56), intraoperative povidone-iodine irrigation (95%CI 0.028-1.98), monofilament suture closure vs. staples (95%CI 1.18-7.19), and occlusive dressing use (95%CI 0.019-0.465), the DA approach showed no significant independent association with PJI (adjusted OR 0.81, 95% CI 0.43-1.54, $p=0.523$).

Discussion: In this large single center study, we observed that the incidence of PJI is influenced by various factors.

Conclusion: Direct anterior approach to the hip does not increase the risk of PJI.

Elevated Fructosamine Levels are Associated with Increased Risk for Periprosthetic Joint Infection Following Total Hip Arthroplasty: A Prospective Multi-center Study

Noam Shohat, Karan Goswami, D'Andrew Gursay, Leigham Breckenridge, Ran Schwarzkopf, Javad Parvizi

Background / Rationale: Based on a recent study, fructosamine was shown to have a promising role in predicting adverse outcomes following total knee arthroplasty

Study Question: The purpose of this study was to assess the utility of fructosamine in predicting adverse outcome in general, and periprosthetic joint infection (PJI) in particular, following total hip arthroplasty (THA).

Methods: A prospective multi-institutional study was conducted. All primary THA were evaluated for glycemic control using fructosamine and HbA1c levels prior to surgery. Adverse outcomes were assessed at a minimum of 1 year from surgery. Primary outcome of interest was periprosthetic joint infection (PJI) defined per the 2018 ICM criteria. Based on previous studies on the subject, a fructosamine level above 292 $\mu\text{mol/L}$ was used to define inadequate glycemic control and as a predictor for adverse outcomes. Univariate and multivariate regression were conducted to evaluate the association between preoperative fructosamine levels and development of adverse outcomes and PJI.

Results: Overall 960 patients participated in the present study and were available for follow up at a minimum 1 year from surgery. Of these, 3.5% (34/960) exhibited inadequate glycemic control based on fructosamine values and these patients were 6.8 times more likely to develop PJI compared to patients who were well controlled (8.8% versus 1.3%, $p=0.014$). The association between high fructosamine levels and increased risk for PJI remained significant after adjusting for age, comorbidities and preoperative HbA1c levels in a regression analysis (adjusted OR 5.04, 95%CI 1.2-21.1).

Discussion: Fructosamine is a good proxy for glycemic control and elevated levels correlate with the risk for subsequent PJI in patients undergoing total hip arthroplasty.

Conclusion: A strong consideration should be given to the use of fructosamine as a glycemia screening tool in patients undergoing surgery.

ID: 29

Laminar Air Flow Does Not Have a Protective Effect on the Rate of Periprosthetic Joint Infection After Primary Total Joint Arthroplasty

Samuel Clarkson, Timothy Tan, Javad Parvizi

Background / Rationale: Whether laminar airflow (LAF) in the operating room (OR) is effective for decreasing periprosthetic joint infection (PJI) following total joint arthroplasty (TJA) remains a clinically significant yet controversial issue

Study Question: This study investigated the association between operating room ventilation systems and the risk of PJI in TJA patients

Methods: We performed a retrospective observational study on consecutive patients undergoing primary total knee arthroplasty (TKA) and total hip arthroplasty (THA) from January 2013-September 2017 in two surgical facilities within a single institution, with a minimum 1-year follow-up. All procedures were performed by five board-certified arthroplasty surgeons. The operating rooms at the facilities were equipped with LAF and turbulent ventilation systems, respectively. Patient characteristics were extracted from clinical records. PJI was defined according to Musculoskeletal Infection Society criteria within 1-year of the index arthroplasty. A multivariate logistic regression model was performed to explore the association between LAF and risk of 1-year PJI, and then a sensitivity analysis using propensity score matching (PSM) was performed to further validate the findings.

Results: A total of 6,972 patients (2,797 TKA, 4,175 THA) were included. The incidence of PJI within 1 year for patients from the facility without laminar flow was similar at 0.4% to that of patients from the facility with laminar flow at 0.5%. In the multivariate logistic regression analysis, after all confounding factors were taken into account, the use of LAF was not significantly associated with reduction of the risk of PJI. After propensity score matching, there was no significant difference in the incidence of PJI within 1 year for patients between the two sites.

Discussion: The use of LAF in the operating room was not associated with a reduced incidence of PJI following primary TJA

Conclusion: With an appropriate perioperative protocol for infection prevention, LAF does not seem to play a protective role in PJI prevention

Predictive modeling with Next generation sequencing: a Validated Multi-Institutional Adjunct for Diagnosis of Periprosthetic Joint Infection

Samuel Clarkson, Karan Goswami, Douglas Dennis, Brian Klatt, Nitin Goyal, Eric Smith, Christopher Pelt, Arthur Malkani, Jon Minter, Michael Cross, Hernan Prieto, Gwo-Chin Lee, Erik Hansen, Carlos Higuera Rueda, Craig Della Valle, Javad Parvizi

Background / Rationale: The clinical relevance of microbial DNA detected via next-generation sequencing (NGS) remains unknown

Study Question: This multicenter study was conceived to: 1) identify species on NGS that may predict periprosthetic joint infection (PJI), then 2) build a predictive model for PJI in a developmental cohort, and 3) validate predictive utility of the model in a separate mul

Methods: Fifteen institutions prospectively collected samples from 194 revision TKA and 184 revision THA between 2017-2019. Synovial fluid, tissue and swabs were obtained intraoperatively and sent to MicrogenDx (Lubbock, TX) for NGS analysis. Reimplantations were excluded. Patients were classified per the 2018 ICM definition of PJI. DNA analysis of community similarities (ANCOM) was used to identify 17 bacterial species of 294 (W -value > 50) for differentiating infected vs. noninfected cases. Logistic regression with LASSO selection and random-forest algorithms were then used to build a model for predicting PJI. ICM classification was the response variable (gold-standard) and species identified through ANCOM were predictors. Patients were randomly allocated 1:1 into training and validation sets. Using the training set, a model for PJI diagnosis was generated. The entire model-building procedure and validation was iterated 1000 times.

Results: The model's assignment accuracy was 75.9%. There was high accuracy in true-negative and false-negative classification using this model, which has previously been a criticism of NGS. Specificity was 97.1%, PPV 75.0% and NPV 76.2%. On comparison of abundance between ICM-positive and ICM-negative patients, *Staphylococcus aureus* was the strongest contributor ($F=0.99$) to model predictive power. In contrast, *Cutibacterium acnes* was less predictive ($F=0.309$) and abundant across infected and noninfected revisions

Discussion: This is the first study to utilize predictive algorithms on a large multicenter dataset to transform analytic NGS data into a clinically relevant diagnostic model

Conclusion: Our collaborative findings suggest NGS may be an independent adjunct for PJI diagnosis, while also facilitating pathogen identification. Future work applying machine-learning will improve accuracy and utility of NGS

Reinfection or Persistence of Periprosthetic Joint Infection? Next generation sequencing Reveals New Findings

Samuel Clarkson, Karan Goswami, Douglas Dennis, Brian Klatt, Nitin Goyal, Eric Smith, Christopher Pelt, Arthur Malkani, Jon Minter, Michael Cross, Hernan Prieto, Gwo-Chin Lee, Erik Hansen, Carlos Higuera Rueda, Craig Della Valle, Javad Parvizi

Background / Rationale: Surgical management of PJI remains challenging with patients failing treatment despite the best efforts. An important question is whether these later failures reflect reinfection or the persistence of infection. Proponents of reinfection believe hosts are vulnerable to developing infection and new organisms emerge. The alternative hypothesis is that later failure is a result of an organism that was present in the joint but was not picked up by initial culture or was not a pathogen initially but became so under antibiotic pressure.

Study Question: This multicenter study explores the above dilemma. Utilizing next-generation sequencing (NGS), we hypothesize that failures after two-stage exchange arthroplasty can be caused by an organism that was present at the time of initial surgery but not isolated

Methods: This prospective study involving 15 institutions collected samples from 635 revision total hip(n=310) and knee(n=325) arthroplasties. Synovial fluid, tissue and swabs were obtained intraoperatively for NGS analysis. Patients were classified per 2018 Consensus definition of PJI. Treatment failure was defined as reoperation for infection that yielded positive cultures, during minimum 1-year follow-up. Concordance of the infecting pathogen cultured at failure with NGS analysis at initial revision was determined

Results: Among the total cohort, 203 revisions were considered infected and 432 were aseptic (based on ICM-criteria). Of the infected cases, 157 were NGS-positive and 46 NGS-negative. Twenty-nine ICM-positive patients (29/157;18.5%) failed by reoperation with an organism confirmed on culture. In 23 of these (23/29;79.3%), the organism at failure was present on NGS at initial revision. The remaining 6 cases detected discordant organisms between initial NGS and culture at failure. Of the 432 ICM-negative patients, NGS identified microbes in 48.1% (208/432) of "aseptic" revisions, and 17 of these failed. Thirteen of the 17 failures (76.5%) were due to an organism previously detected by NGS at initial revision

Discussion: Our collaborative findings suggest that most failures (79.3%) by infection recurrence could be attributed to an organism previously detected by NGS at index revision surgery

Conclusion: Failures after two-stage exchange arthroplasty can be caused by an organism that was present at the time of initial surgery

Who Will Fail Following Irrigation and Debridement for Periprosthetic Joint Infection: A Machine Learning Based Validated Tool

Noam Shohat, Karan Goswami, Timothy Tan, Michael Yayac, Alex Soriano, Ricardo Sousa, Marjan Wouthuyzen-Bakker, Javad Parvizi

Background / Rationale: Failure of irrigation and debridement (I&D) for periprosthetic joint infection (PJI) is influenced by numerous host, surgical and pathogen related factors

Study Question: We aimed to develop and validate a practical, easy to use tool based on machine learning that may accurately predict outcome following I&D surgery taking into account the influence of numerous factors

Methods: This was an international, multicenter retrospective study of 1,174 revision total hip (THA) and knee arthroplasties (TKA) undergoing I&D for PJI between 2005 and 2017. PJI was defined using the Musculoskeletal Infection Society (MSIS) criteria. Fifty-two variables including demographics, comorbidities, as well as clinical and laboratory findings were evaluated using random forest machine learning analysis. The algorithm was then validated through cross-validation

Results: Of the 1,174 patients that were included in the study, 405 patients (34.5%) failed treatment. Using random forest analysis, an algorithm that provides the probability for failure for each specific patient was created

Discussion: By order of importance, the ten most important variables associated with failure of I&D were serum C-reactive protein levels, positive blood cultures, indication for index arthroplasty other than osteoarthritis, not exchanging the modular components, use of immunosuppressive medication, late acute (hematogenous) infections, methicillin resistant *S. aureus* infection, overlying skin infection, polymicrobial infection and older age. The algorithm had good discriminatory capability (area under the curve = 0.74). Cross-validation showed similar probabilities comparing predicted and observed failures indicating high accuracy of the model.

Conclusion: This is the first study in the orthopedic literature to use machine learning as a tool for predicting outcomes following I&D surgery. The developed algorithm provides the medical community a tool that can be employed in clinical decision making and improve patient care. Future studies should aid in further validating this tool on additional cohorts

ID: 34

Hepatitis C Patients have Higher Risk of Revisions after TJA

Emanuele Chisari, Christopher Gardner, Javad Parvizi

Background / Rationale: Multiple studies reported that patients with a history of Hepatitis C virus (HCV) have a higher risk for postoperative complications, revisions, and periprosthetic joint infections (PJI). However, not all HCV positive patients show the same outcomes, and patients treated for HVC before total joint arthroplasty (TJA) seem to have a substantially lower risk of infections and revisions

Study Question: We hypothesized that HCV diagnosis is not an independent risk factor for periprosthetic joint infection (PJI).

Methods: A retrospective matched cohort study was designed. Primary endpoint was PJI risk at 2-years. Secondary endpoints were aseptic revisions, discharge to a rehab facility, complications up to 30 days, and readmission up to 90 days. ICD-9 and -10 codes were used to identify the patients. A chart review was used to confirm diagnosis and evaluate proof of aviremia after treatment, also named sustained viral response (SVR). 214 patients with HCV were identified and matched (3:1) for age, sex, BMI, year of surgery, and joint affected with 642 otherwise healthy individuals undergoing TJA

Results: Patients with HCV diagnosis had a lower incidence of PJI (5.14%) versus the control cohort (1.71%). In a subgroup analysis of patients with documented SVR, the incidence of PJI was 9.5%.

Discussion: When logistic bivariate regression was performed, a diagnosis of HCV was found to be an independent risk factor for PJI and aseptic revisions. No difference was found in the rate of postoperative discharge, complications, and readmissions.

Conclusion: Based on the findings, it appears that patients with HCV are at higher risk for PJI and revision for aseptic failure after TJA. Even when aviremia is reported, patients still have an increased incidence of PJI. The reason for this finding is unknown but could be related to a chronic inflammatory status and lower overall immunity of the patient.

ID: 36

Inflammatory Bowel Diseases Increases the Risk of Periprosthetic Joint Infection

Emanuele Chisari, Darran D'Mello, Javad Parvizi

Background / Rationale: A large body of evidence is emerging to implicate that dysregulation of the gut microbiome (dysbiosis) increases the risk of surgical site infections. Gut dysbiosis is known to occur in patients with inflammatory bowel disease (IBD), allowing for translocation of bacteria across the inflamed and highly permeable intestinal mucosal wall.

Study Question: This study hypothesised that IBD is an independent risk factor for periprosthetic joint infection (PJI).

Methods: A retrospective matched cohort study was designed. Primary endpoint was PJI risk at 1-year. Secondary endpoints were aseptic revisions, as well as discharge to rehab facility, complications up to 30 days, and readmission up to 90 days after TJA. ICD-9 and -10 codes were used to identify the patients. Chart review was used to confirm diagnosis. Using our institutional database 154 patients with IBD were identified and matched (3 to 1) for age, sex, BMI, year of surgery and joint affected with 462 otherwise healthy individuals with osteoarthritis undergoing TJA.

Results: The incidence of PJI was 4.55% among patients with IBD versus 1.32% among control cohort ($p=0.024$).

Discussion: When logistic bivariate regression was performed, a diagnosis of IBD was found to be an independent risk factor for PJI (OR 3.56 95% C.I. 1.17 - 11.23; $p=0.024$) and aseptic revisions (OR 3.47, 95% C.I. 1.30 - 3.47; $p=0.012$). The rate of postoperative complications was also higher in patients with IBD.

Conclusion: Based on the findings of this study, it appears that patients with IBD are at higher risk for PJI and revision for aseptic failure after TJA. The exact reason for this finding is not known but could be related to the bacterial translocation from the inflamed intestinal mucosa, the immunosuppressive status of these patients, and potentially other factors. Some of the so-called aseptic failures may be also as a result of infection that may have escaped detection and/or recognition.

Organism Profile Causing Periprosthetic Joint Infection: The List is Growing

Santiago Restrepo, Hannah Groff, Karan Goswami, Emanuele Chisari, Javad Parvizi

Background / Rationale: It is traditionally stated that around 80% of all periprosthetic joint infections (PJI) are caused by well-known gram positive organisms such as *Staphylococcus aureus*.

Study Question: With the advances in diagnostic modalities and improved abilities to isolate infective organisms, we believe the organism profile causing PJI has changed over time and includes numerous other organisms that were either not recognized as pathogens and/or c

Methods: We retrospectively reviewed the medical records of 1,363 patients with confirmed PJI (559 THA and 804 TKA) who received treatment at our institution between 2000 and 2019. Pertinent data related to demographics, microbiological findings, and outcome of treatment were collected. Organisms were differentiated using culture or confirmed by Matrix-Assisted Laser Desorption Ionization-time of flight (MALDI-tof) mass spectrometry. Statistical analysis included logistic regressions.

Results: There was a total of 26 different species of organisms that resulted in PJI in our cohort. The rate of PJI caused by slow growing organisms, that are catalase negative, such as *Streptococcal viridans* (OR 1.244; 95% CI 1.036-1.494), *Streptococcus agalactiae* (OR 1.513; 95% CI 1.207-1.898), and *Staphylococcus epidermidis* (OR 1.321; 95% CI 1.191-1.466) has been increasing over time. In contrast, the incidence of PJI caused by coagulase-negative *Staphylococcus* (OR 0.954; 95% CI 0.927-0.981); resistant species (OR 0.962, 95% CI 0.931-0.995), and Gram-positive species (OR 0.94, 95% CI 0.914-0.966) decreased over time. Notably, there was a higher prevalence of *Streptococcal* PJI (OR 0.551, 95% CI 0.374-0.812) and culture-negative PJI (OR 0.652, 95% CI 0.478-0.890) seen in knees versus hips. The rate of culture negative PJI also increased from 20% in 2000 to 28% in 2019. In the latter years of the study, very unusual list of organisms causing PJI were also identified.

Discussion: This study reveals that the list of organism causing PJI has expanded in recent years. The study also find that some the slow growing organisms that were previously believed to be "contaminants" can and do cause PJI in a considerable number of patients. The number of culture negative cases of PJI has also increased at our institution over the years. There are a number of explanations for the latter finding, perhaps with the most important reason

Conclusion: The organism profile causing PJI has changed over time

ID: 40

Calprotectin Lateral Flow Test: A Potential Rule Out Test for Periprosthetic Joint Infection

Carlos Higuera, Jared Warren, Hiba Anis, Kathy Bowers, Tejbir Pannu, Jesus Villa, Alison Klika, Jessica Colon-Franco, Nicolas Piuze

Background / Rationale: Several options to standardize the definition of periprosthetic joint infection (PJI) have been created including the 2013 Musculoskeletal Infection Society (MSIS), 2018 Intentional Consensus Meeting (ICM), and the 2019 proposed European Bone and Joint Infection Society (EBJIS) criteria. Synovial fluid biomarkers have been investigated in an effort to simplify and improve the diagnosis of PJI.

Study Question: What is the sensitivity, specificity, positive, and negative predicted values (PPV and NPV, respectively) of a calprotectin point of care (POC) test for diagnosing PJI in revision total knee arthroplasty (TKA) patients comparing different sets of criteria

Methods: From October 2018 to January 2020 and under IRB approval 123 intraoperative samples of synovial fluid were prospectively collected at two academic hospitals in the same institution from revision TKA patients. All patients underwent standard clinical and laboratory evaluation for PJI at our institution, allowing for categorization using the 3 criteria. Patients were adjudicated by 2 blinded and independent reviewers for the 3 sets of criteria. The 3 criteria agreed 91.8% of the time. Four likely cases by the 2019 proposed EBJIS were considered unlikely and 1 inconclusive case by the 2018 ICM was considered not infected for the purposes of analysis. A threshold of ≥ 50 mg/L indicated PJI. Sensitivities, specificities, PPV, NPV, and areas under the curve (AUC) were calculated for the 3 sets of criteria.

Results: Using 2013 MSIS criteria the calprotectin POC test demonstrated a sensitivity, specificity, PPV, NPV AUC of 98.1%, 95.7%, 94.5%, 98.5%, and 0.969, respectively. Using 2018 ICM the POC test demonstrated a sensitivity, specificity, PPV, NPV and (AUC) of 98.2%, 98.5%, 98.2%, 98.5%, and 0.984, respectively. Using the 2019 proposed EBJIS criteria the POC test demonstrated a sensitivity, specificity, PPV, NPV and area under the curve (AUC) of 93.2%, 100.0%, 100.0%, 94.2%, and 0.966, respectively

Discussion: These results are promising and suggest that the calprotectin lateral flow test may be used as a rule out test in a cost conscious health care model or when conventional diagnostic tools may not be available.

Conclusion: The calprotectin lateral flow POC test has an excellent sensitivity and specificity regardless of the set of criteria used to define PJI.

Tables 4: Sensitivities, Specificities, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and Areas Under the Curve (AUCs) and of the Calprotectin POC Test by Criteria

A) 2013 MSIS				
POC Test	Positive	Positive	Negative	
	Negative	1	3	67
Sensitivity	Specificity	PPV	NPV	AUC
98.1%	95.7%	94.5%	98.5%	0.969
B) 2018 ICM				
POC Test	Positive	Infected	Not Infected	
	Negative	1	1	67
Sensitivity	Specificity	PPV	NPV	AUC
98.2%	98.5%	98.2%	98.5%	0.984
C) Proposed 2019 EBJIS				
POC Test	Positive	Confirmed	Unlikely	
	Negative	4	0	65
Sensitivity	Specificity	PPV	NPV	AUC
93.2%	100.0%	100.0%	94.2%	0.966

MSIS - Musculoskeletal Infection Society; ICM - International Consensus Meeting; EBJIS - European Bone and Joint Infection Society

Rotational gluteus maximus flap with reimplantation of hip arthroplasty in patients that have prior resection arthroplasty

Herrick Siegel, Mattherw Hess, Christopher Odom, Kevin Wall

Background / Rationale:

Resection arthroplasty (RA) remains a surgical option for the treatment of refractory hip arthroplasty (THA) infections; however reimplantation of hip implants may be a challenge due to contracture, loss of soft tissue plans and deficiency of abductors. Soft tissue loss around the greater trochanter may also lead to poor wound healing with possible recurrent infection and wound dehiscence. A gluteus maximus muscle may be rotated to cover the greater trochanter to not only help with abductor function, but to assist with soft tissue coverage and reduce the risk of wound complications.

Study Question: Does a rotational gluteal flap assist with wound closure and abductor reconstruction in patients with prior history of hip resection arthroplasty?

Methods: Fourteen patients undergoing a reimplantation procedure with a history of prior RA were treated with revision THA with rotational gluteus flap. Twelve of 14 patients were noted to have significant abductor compromise including complete loss of abductor insertion in 10 of 12. All 14 patients had previous lateral based incision and were treated with multiple prior hip surgeries for infection. At the time of reimplantation, patients were confirmed by CRP and ESR, along with aspiration, to show no evidence of infection.

Results: The anterior third of the gluteus maximus was divided and rotated from distal to the greater trochanter as well as residual anterior capsule and/or TFL fascia. Calcium phosphate beads containing vancomycin and tobramycin were used in all cases and placed beneath the flap. At 6 months follow up, 13 of 14 patients had healed incisions without drainage or erythema. Of the 10 patients with a minimum of 1 year follow, a trendelberg gait was noted in 2, minimal trendelenberg in 5 and 3 had a normal gait.

Discussion: Conversion from resection arthroplasty to revision total hip arthroplasty is a challenge. By rotating the gluteus maximus anteriorly in line with the abductor force to stabilize the pelvis, a Trendelberg gait was minimized or eliminated in the majority of patients. The rotated muscle also helped decrease dead space and reduced of post operative drainage.

Conclusion: We recommend the gluteus flap procedure be a part of the training for total joint surgeons and that it is useful particularly in patients with prior resection arthroplasty procedures for soft tissue coverage and abductor reconstruction.

ID: 47

Resection Arthroplasty for Periprosthetic Joint Infection Following Total Hip or Knee Arthroplasty is Associated with High Attrition Rate and Mortality

Jesse Otero, Cameron Barton, David Wang, Qiang An, Timothy Brown, John Callaghan

Background / Rationale: While previous studies have described risk factors for failure of two stage revision for periprosthetic joint infection (PJI), little data exists pertaining to the fate of patients who undergo initial resection and antibiotic spacer implantation.

Study Question: What are the failure rates after resection and antibiotic spacer placement for chronic PJI, defined as failure to achieve infection-free two-stage revision, septic failure of second-stage reimplantation if performed, and mortality? Second, what risk factors

Methods: A retrospective cohort study was performed including all patients with ≥ 2 -year follow-up who underwent first stage resection of a hip or knee periprosthetic joint infection (PJI) from 2008-2015. Patient demographics, laboratory, and health status variables were collected. Univariate pairwise comparison followed by multivariate regression analysis was used to determine risk factors for failure outcomes.

Results: Eighty-nine patients underwent resection arthroplasty in a planned two-stage exchange protocol (27 hips, 62 knees). Mean age was 64 years (range 43-84), 56.2% male, and mean follow-up was 56.3 months. 68.5% (61/89) of patients underwent second stage revision. Of the 61 patients that completed a two-stage protocol, 14.8% (9/61) of patients failed with diagnosis of recurrent infection. Mortality rate was 23.6%. Multivariate analysis identified risk factors for failure to achieve an infection free two-stage revision as: polymicrobial infection ($p < .004$; Adjusted odds ratio (AOR) 7.8; 95% confidence interval (CI) 2.1-29.0), McPherson extremity grade 3 ($p < .024$; AOR 4.1; 95% CI 1.2-14.3), and history of prior resection ($p < .013$; AOR 4.7; 95% CI 1.4-16.4).

Discussion: Only 68.5% of patients completed the 2-stage protocol. 58.4% of patients achieved an infection-free 2-stage revision. Of those that completed the two-stage protocol, 14.8% of patients failed 2-stage revision with diagnosis of recurrent infection. Risk factors for failure to achieve an infection free two-stage revision were: polymicrobial infection, McPherson extremity grade 3, and history of prior resection.

Conclusion: Patients undergoing resection arthroplasty for PJI are at high risk of death and failure to complete the 2-stage protocol.

Extended Oral Antibiotics Prevent PJI in High-Risk Cases: 3,862 Patients with 1-Year Follow-Up

Michael Kheir, Julian Dilley, Mary Ziemba-Davis, R. Michael Meneghini

Background / Rationale: Surgical and host factors predispose patients to periprosthetic joint infection (PJI) following primary total knee (TKA) and hip (THA) arthroplasty. While surgical factors are readily modifiable, host factors can be challenging and there are limited data demonstrating that preoperative optimization decreases risk.

Study Question: This study's objective was to expand the follow-up period and sample size of our prior study demonstrating that extended oral antibiotic prophylaxis reduces 90-day infection rates in high-risk patients.

Methods: 3,862 consecutive primary TKAs and THAs performed between 2011 and 2019 at a suburban academic hospital with modern perioperative and infection-prevention protocols were retrospectively reviewed. Beginning in 2015, a 7-day oral antibiotic prophylaxis protocol was implemented after discharge for patients at high risk for PJI. The percentage of high-risk patients diagnosed with PJI within 1 year were compared between groups that did and did not receive extended antibiotic prophylaxis. Logistic regression was performed, with $p < 0.05$ statistically significant.

Results: Overall 1-year infection rates were 0.8% and 2.3% after TKA and THA, respectively. High-risk patients without extended antibiotic prophylaxis were 3.1 ($p=0.025$) and 3.2 ($p=0.008$) times more likely to develop PJI after TKA and THA, respectively, than high-risk patients with antibiotic prophylaxis. There was no difference in the infection rate between high-risk patients who received antibiotics and low-risk patients (0.9% vs. 1.3%, respectively; $p=0.391$) with numbers available.

Discussion: Extended antibiotic prophylaxis led to a statistically significant and clinically meaningful reduction in 1-year infection rates of patients at high risk for infection. In fact, the PJI rate in high-risk patients who received antibiotics was less than in low-risk patients. The 90-day PJI prevention results from our original study were upheld out to one year, and in a much larger expanded dataset.

Conclusion: Extended oral antibiotic prophylaxis may be a simple measure to effectively counteract poor host factors and further study is warranted.

Diagnostic Value of D-Dimer for Periprosthetic Shoulder Infection

Benjamin Zmistowski, Thema Nicholson, Surena Namdari

Background / Rationale: Diagnosis of periprosthetic shoulder infection continues to challenge the shoulder arthroplasty community. Serum D-dimer has proven effective as a screening tool for periprosthetic joint infection in other major joints.

Study Question: This study investigates the utility of D-dimer for diagnosis of periprosthetic shoulder infection.

Methods: Between March, 2016 and March, 2020, 97 patients undergoing revision total shoulder arthroplasty (anatomic or reverse) at a single institution had pre-operative serum testing with C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and D-dimer. Patient charts were reviewed to determine the surgeon indication for revision and classify the case as definitely infected, probably infected, possible infected, or unlikely to be infected according to the International Consensus Meeting (ICM) definition of periprosthetic shoulder infection. Statistical analyses, including receiver operating characteristic (ROC) curve analysis, were performed to quantify the predictive value of D-dimer for periprosthetic shoulder infection.

Results: These 97 patients had an average age of 70.4 (range: 40 – 90) years and 55 (56.7%) were male. The ICM criteria identified 16 cases as definite or probable infection. Surgeon-defined septic cases had an average D-dimer of 803.59 ng/mL compared to 540.6 (p=0.25) for aseptic indications. In contrast, D-dimer was significantly elevated in definite or probable infections (1090.3) compared to possible or unlikely infections (503.9; p=0.02) by the ICM definition. When utilizing the ICM definition as the gold-standard in ROC analysis, D-dimer had an AUC of 0.65 compared to 0.63 and 0.68 for ESR and CRP, respectively. A D-dimer of 642ng/mL provided a sensitivity and specificity of 61% and 77%, respectively, for diagnosing an ICM definite or probable infection. In comparison, a CRP threshold of 7 mg/L provided a sensitivity and specificity of 69% and 60%, respectively; an ESR of 28 mm/hr provided a sensitivity and specificity of 61% and 77%, respectively. Using these tests in combination did not substantially improve their diagnostic value.

Discussion: While this low-cost and non-invasive test has proven effective in diagnosing periprosthetic infection in other major joints, infection of the shoulder continues to be a challenging problem to diagnose.

Conclusion: D-dimer is as effective as ESR and CRP in detecting periprosthetic shoulder infection.

SYMPOSIUM #2

“Exploring the Unique Benefits of Using Bacteriophages to Treat MSK Infections from the Bench to the Bedside”

Moderator: Hesham Abdelbary

Hesham Abdelbary, MD
Orthopaedic Surgeon
University of Ottawa
Ottawa, Canada

Cynthia Barbosa da Silveira, PhD
Biologist
University of Miami
Miami, FL

Gina Suh, MD
Infectious Disease Physician
Mayo Clinic
Rochester, MN

Eddie Schwarz, PhD
Scientist
University of Rochester Medical Center
Rochester, NY

Session II

Basic Science

Moderators: Alex C. McLaren, MD; Laura Certain MD

ID: 5

A Novel Activated-Zinc Antiseptic Solution Effective Against *Staphylococcus aureus* and *Pseudomonas aeruginosa* in a Pig Model

Derek Hill, Cody Pinger, Erica Noland, Kevin Morton, Alessandra Agostinho Hunt, Elizabeth Pensler, Sarah Cantu, Paul Attar, Ahmed Siddiqi

Background / Rationale: Identifying the optimal agent for irrigation for periprosthetic joint infection remains challenging as there is limited data. The ideal solution should have minimal cytotoxicity while maintaining bactericidal activity. We developed a novel activated-zinc solution containing zinc-chloride (ZnCl_2) and sodium-chlorite (NaClO_2).

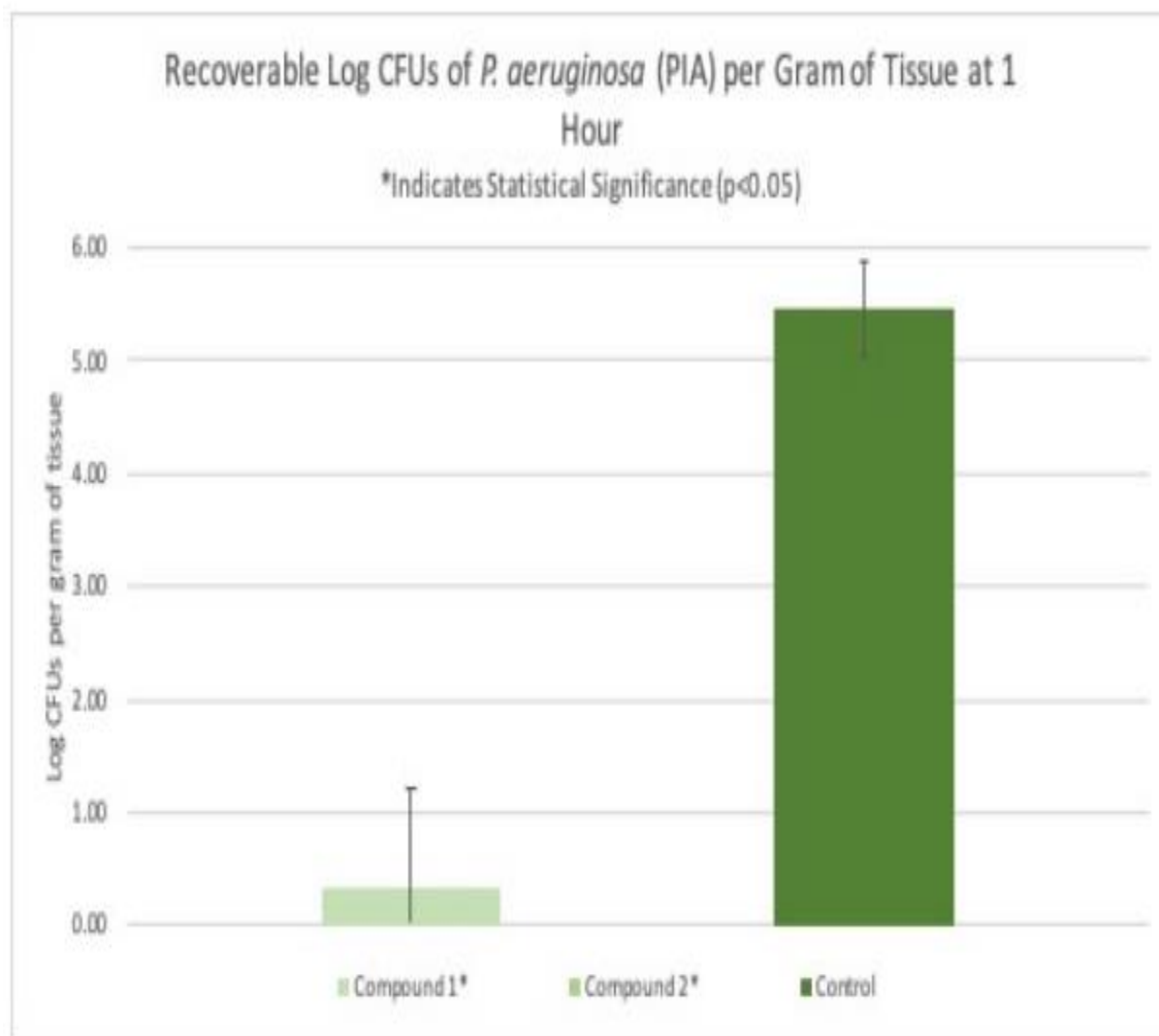
Study Question: The purpose of this study was 1.) to investigate the antimicrobial efficacy of 2 concentrations ("CZ1", "CZ2") against *Staphylococcus aureus* and *Pseudomonas aeruginosa* and 2.) to evaluate untoward effects of the solution on local wound tissue 24 hours after solution exposure in pig wound models.

Methods: The study was conducted and reported in accordance to ARRIVE guidelines. We created twenty-four 1.5cm wounds on the back of a Yorkshire-cross pig. Wounds were inoculated with standardized *Pseudomonas* and *S. aureus*. 8 wounds were designated as controls (inoculum without treatment), 8 treated with CZ1, and 8 with CZ2. Punch biopsies were taken 1 hour after treatment and bacteria quantified. Wound necrosis/neutrophil infiltrate was measured 24-hours post-exposure.

Results: After 1-hour, the control, CZ1 and CZ2 wounds had total bacteria of 5.7, 2.8 and 3.5 log CFU/g, respectively ($p=0.017$). The control, CZ1 and CZ2 wounds had *S. aureus* of 5.3, 2.3 and 1.6 log CFU/g, respectively ($p=0.009$). The control, CZ1 and CZ2 wounds had *Pseudomonas* of 5.5, 0.3 and 0.0 log CFU/g, respectively ($p=0.000$). After 24 hours of exposure to CZ1 and CZ2, there was no statistically significant increased necrosis ($p=0.12$, $p=0.31$, respectively). CZ1 had increased, moderate neutrophil infiltrates ($p=0.04$) when compared to controls, however, CZ2 was not significant ($p=0.12$).

Discussion: Our novel solution demonstrated 99.5-99.9% reduction in total bacteria, 99.9-99.98 % reduction in *S. aureus*, and 100% eradication of *Pseudomonas* 1-hour after exposure, without significantly increased necrosis and no-to-minimally-increased neutrophil infiltrate.

Conclusion: This novel solution may provide another significant tool in the arsenal to treat and/or prevent PJI and other wound infections.



ID: 7

Staphylococcus aureus initially and preferentially utilizes biofilm mediated tolerance prior to antibiotic resistance

Derek Amanatullah, Robert Manasherob, Jake Mooney, David Lowenberg, Paul Bollyky

Background / Rationale: Because we often study metal-associated biofilms, a major barrier in developing effective therapies for periprosthetic joint infection (PJI) is understanding the cells that reside within biofilm.

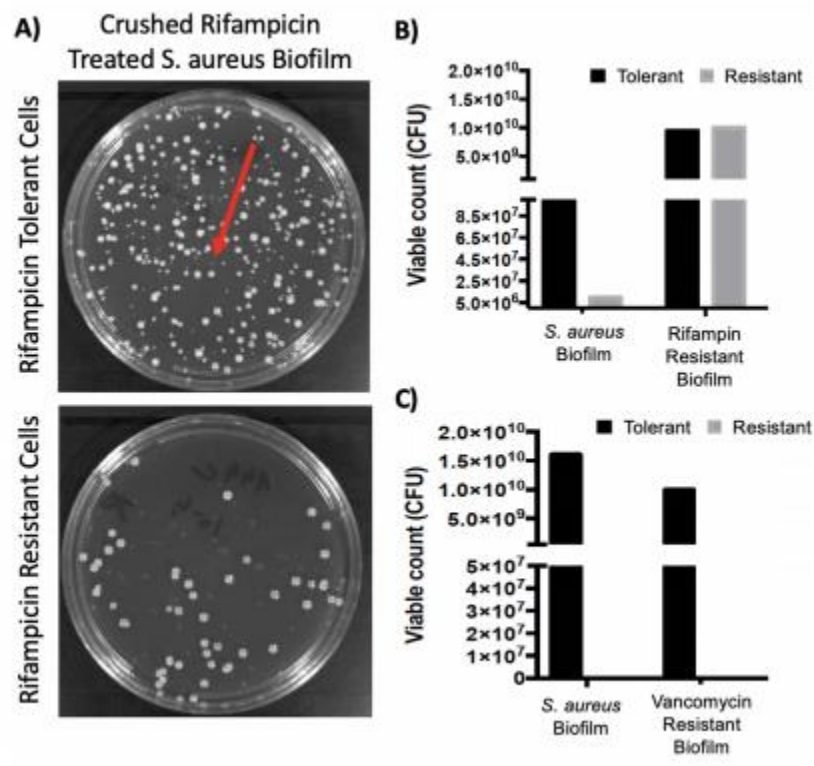
Study Question: We asked how a biofilm penetrating antibiotic, like rifampicin, and a non-penetrating antibiotic, like vancomycin, influence the cells that reside within the biofilm.

Methods: *S. aureus* biofilms were grown on membranes and evaluated by viability counting after membrane destruction and serial dilution as well as scanning electron microscopy. Membranes were re-incubated at various times to fresh agar with or without 2-200 ug/ml of rifampicin and/or 1-50 ug/ml of vancomycin.

Results: *S. aureus* survived rifampicin and vancomycin. Rifampicin survival was associated with the emergence of antibiotic tolerant cells, including small colony variants (SCVs, Figure 1A - arrow). Tolerance developed prior to resistance to rifampicin and tolerant cells were an order of magnitude more abundant than resistant cells with an antibiotic naive biofilm (Figure 1B). Tolerance was not observed in biofilms seeded with rifampicin *S. aureus* (Figure 1B). Tolerance was the preferred mechanism of surviving vancomycin whether biofilms were seeded with vancomycin resistant or naive *S. aureus* (Figure 1C).

Discussion: SCVs are typically slow growing colonies that exist as bacterial sub-populations and arise after exposure to antibiotics. SCVs are associated with persistent and chronic infections. The administration of antibiotics in the setting of PJI may create an abundant persister population, since tolerance is the primary mechanism of initially evading antibiotics. Antibiotics that do not penetrate biofilm may not exert enough selective pressure against sessile bacteria. Such a phenomenon argues against the utilization of the distributed genome to facilitate bacterial resistance with a biofilm. This phenomenon may be confined to bacteria that are transitioning from the sessile to planktonic phase in an attempt establishing a new microcolony.

Conclusion: In an established PJI, *S. aureus* initially and preferentially utilizes tolerance prior resistance to survive antibiotics. Antibiotics with poor biofilm penetration may not foster resistance as fast as biofilm penetrating antibiotics during PJI.



Staphylococcus epidermidis Biofilms Have a High Tolerance to Antibiotics in Periprosthetic Joint Infection

John Koch, Taylor Pust, Alex Cappellini, Jonathan Mandell, Dongzhu Ma, Neel Shah, Kimberly Brothers, Kenneth Urish

Background / Rationale: *Staphylococcus epidermidis* biofilm displays extensive antibiotic tolerance, which creates challenges in the treatment of total knee and hip arthroplasty periprosthetic joint infection (PJI). From a clinical perspective, planktonic bacteria from infection site are used to determine antibiotic sensitivity. However, *S. epidermidis* exists primarily as a biofilm in PJI. We hypothesized mature *S. epidermidis* biofilms would have an increased tolerance to antibiotics as compared to planktonic *S. epidermidis*.

Study Question: Is there a significant difference between planktonic and biofilm antibiotic sensitivity?

Methods: Planktonic MIC and MBC were assessed using high throughput standardized CLSI assay protocols. Serial dilutions of 8 antibiotics used in the treatment of *S. epidermidis* were assessed in each isolate. MIC was assessed using PrestoBlue viability assay. MBC was analyzed using blood agar drop plates. Mature biofilms of each strain were grown over 48 hours plastic culture plates, and biofilm MIC (MBIC) and biofilm MBC (MBBC) were analyzed.

Results: Excluding resistant strains, all planktonic MICs and MBCs were detectable up to 125ug/ml. Matched sample analysis showed the MIC for all strains did significantly increase in biofilms using a Wilcoxon test (Fig 1). A wide range of MIC and MBC values were observed between antibiotics. Only rifampin, vancomycin, and doxycycline achieved a bactericidal concentration within our dosing range. Matched sample analysis showed the MBC for all strains did significantly increase in biofilms using a Wilcoxon test (Fig 2).

Discussion: *S. epidermidis* biofilm was observed to have a high tolerance to antibiotics as compared to planktonic culture. Rifampin, doxycycline, and vancomycin were the only antibiotics that had measurable biofilm MBC. There were large variations in biofilm antibiotic sensitivities between different *S. aureus* clinical isolates as compared to planktonic antibiotic sensitivity. Rifampin, doxycycline, and vancomycin were the most effective antibiotics at decreasing *S. epidermidis* biofilm mass.

Conclusion: This study suggests there is a non-specific change in antibiotic tolerance that occurs between planktonic and biofilm stages in bacterial infections. In addition, our data suggests rifampin, doxycycline, and daptomycin demonstrated the highest efficacy against in vitro biofilms.

The *Staphylococcus aureus* Toxin-Antitoxin system YefM-YoeB is associated with extracellular dependent antibiotic tolerance and biofilm formation

Kimberly Brothers, Dongzhu Ma, Kenneth Urish

Background / Rationale: The high antibiotic tolerance of *Staphylococcus aureus* biofilms are associated with challenges for treating periprosthetic joint infection. The toxin-antitoxin system, YefM-YoeB, is thought to be a regulator for antibiotic tolerance, but its physiological role is unknown. We hypothesized the toxin-antitoxin yoeB homologs contribute to *S. aureus* biofilm formation and biofilm antibiotic tolerance.

Study Question: This study was to determine phenotypes associated with *S. aureus* yoeB homologs in periprosthetic joint infection.

Methods: YoeB1 and yoeB2 mutants were created in Newman and JE2 *S. aureus* strain. A biofilm assay was performed on titanium rods. Quantitative agar culture was used to measure biofilm formation. Vancomycin and cefazolin biofilm susceptibility was measured using a CLSI protocol. Dot blotting was used to quantify polysaccharide intercellular adhesion (PIA). Fluorescence of extracellular DNA (eDNA) was measured using a standard validated assay. Lastly, a neutropenic mouse model was used to confirm in vivo phenotypes.

Results: Disruption of yoeB1 and yoeB2 resulted in decreased biofilm formation by 82%, 83% in JE2 ($p < 0.01$) and 49%, 50% in Newman ($p < 0.01$); Meanwhile, reduced biofilm antibiotic tolerance to vancomycin and cefazolin in comparison to WT ($p < 0.01$). YoeB1 and yoeB2 mutants had 38% and 34% less PIA in comparison to WT, respectively ($p < 0.01$). Treatment with sodium metaperiodate increased biofilm formation. Treatment with DNase I decreased biofilm formation, but not when the expression of yoeB1 or yoeB2 was disrupted. Furthermore, yoeB1 and yoeB2 mutants had 57% and 61% less eDNA in comparison to WT, respectively in JE2 ($p < 0.01$). Finally, mutation of yoeB1 and yoeB2 resulted in reduced bacterial virulence by 42% and 40% in a neutropenic mouse abscess model ($p < 0.05$).

Discussion: Loss of yoeB1 and yoeB2 expression resulted in decreased biofilm formation and reduced biofilm antibiotic tolerance. Treatment with sodium metaperiodate increased biofilm, indicating biofilm formation may increase under conditions of oxidative stress. eDNA quantification demonstrated a higher eDNA content in WT strains in comparison to yoeB mutants. Thus, eDNA may be involved in regulation of biofilm formation in the Newman strain.

Conclusion: *S. aureus* YefM-YoeB system is associated with antibiotic tolerance, biofilm formation, and virulence.

ID: 12

Sub-MIC vancomycin promotes *Staphylococcus aureus* biofilm formation, infection, and pathogenesis.

Kenneth Urish, Masashi Taguchi, Kimberly Brothers, Lance Thurlow, Dongzhu Ma

Background / Rationale: Antibiotic stewardship is a cornerstone in the strategy to prevent the development of antibiotic resistant organisms. This has great public health benefit protecting the availability of effective antibiotics, but less obvious benefit at the individual level. The focus of this study was to determine the effect of sub-minimal inhibitory concentrations (MIC) of vancomycin on *Staphylococcus aureus*. We hypothesized that sub-MIC levels of vancomycin could increase biofilm formation and rates of infection.

Study Question: This study is to determine the effect of sub-MIC levels of vancomycin on *S. aureus* infection.

Methods: Bacteria were grown planktonically in a 96-well plate and was monitored using spectrophotometry. Quantitative agar culture was used to measure *S. aureus* (JE2) biofilm biomass on titanium rods at sub-MIC levels of vancomycin (0.00, 0.25, 0.50 µg/ml). Etest strips were used to quantify MIC. A periprosthetic joint infection mouse model was used to confirm phenotypes in vivo.

Results: Increased densities of *S. aureus* were observed near the perimeter of growth inhibitory areas of vancomycin. At 1/4 and 1/2 MIC, increased biofilm formation was observed at approximately 150% ($p < 0.05$) and 244% ($p < 0.01$) in comparison to controls at day 3. In the mouse abscess model, the biofilm mass (CFU) of sub-MIC group was 7.5×10^6 and control was 5.8×10^5 at 3 days post infection ($p < 0.01$). The infection rate was 44.38% (Control) and 62.08% (sub-MIC) at 3 days post infection ($p = 0.03$).

Discussion: Sub-MIC concentrations of vancomycin promoted *S. aureus* planktonic growth and biofilm formation, phenotypic measures of bacterial virulence. This phenotype induced by sub-MIC levels of vancomycin was observed to increase rates of infection and pathogenesis in our mouse animal model. Risks of sub-MIC concentrations with vancomycin in orthopaedic procedures are greater as there is decreased bioavailability in musculoskeletal tissue in comparison to other antibiotics. This highlights the importance of proper antibiotic stewardship and dosing of vancomycin for both surgical prophylaxis and treatment of orthopaedic infection.

Conclusion: Proper antibiotic stewardship has the potential to improve individual outcomes for the patient by decreasing rates of infection.

ID: 15

Differences between Acute and Chronic Periprosthetic Joint Infection in a Mouse Model; Transition from an acute to chronic infection start at an early time period.

Masashi Taguchi, Shinsuke Kihara, Peter Mittwede, Kimberly Brothers, Freddie Fu, Kenneth Urish

Background / Rationale: There is little understanding of the difference between acute and chronic periprosthetic joint infection from the perspective of bacterial pathogenesis.

Study Question: The objective of this study was to determine spatial and temporal differences between acute and chronic PJI.

Methods: A mouse PJI model was used where a 3D printed titanium tibial implant was placed in the proximal tibia with poly(methyl methacrylate). *Staphylococcus aureus* (SH1000) was injected into the intra-articular space immediately after surgery at a density of 1×10^6 CFU. Antibiotic treatment with cefazolin (50 mg/kg, three times a day) was initiated at several time points. Migration of bacteria as a function of time was determined using an agar culture assay. Bacteria colonies on the implant were quantified by pixel density around the articular surface and metaphyseal bone. Biofilm mass was determined by using quantitative culture from the implant and proximal tibia.

Results: At 1 hour post infection, bacterial colonies were only identified on the articular surface of the implant. After this initial time point, bacteria were observed to progressively migrate into the distal metaphysis. *S. aureus* total bacterial burden reached a maximum by three days post infection for both the implant and proximal tibia before rapidly decreasing in later days post infection. When cefazolin treatment was started on day 1, 50% of infections were cleared and implants were culture negative after 7 days. However, cefazolin was unable to clear *S. aureus* infection when antibiotics were held for two days.

Discussion: In the acute infectious process, the spatial distribution of infection progressed into the distal metaphysis and an early osteomyelitis developed. An antibiotic tolerant biofilm formed quickly within the first two days of the infection. The overall bacterial burden increased on both the implant and surrounding metaphyseal bone. After day 3, a chronic infection developed where there was little change in bacterial distribution or burden as a function of time. The transition from acute to chronic infection occurred within one week.

Conclusion: Transition from acute to chronic infection began on day 3 post infection and continued over a one week time period. The establishment of chronic infection was associated with an antibiotic tolerant biofilm that could not be cleared by cefazolin treatment.

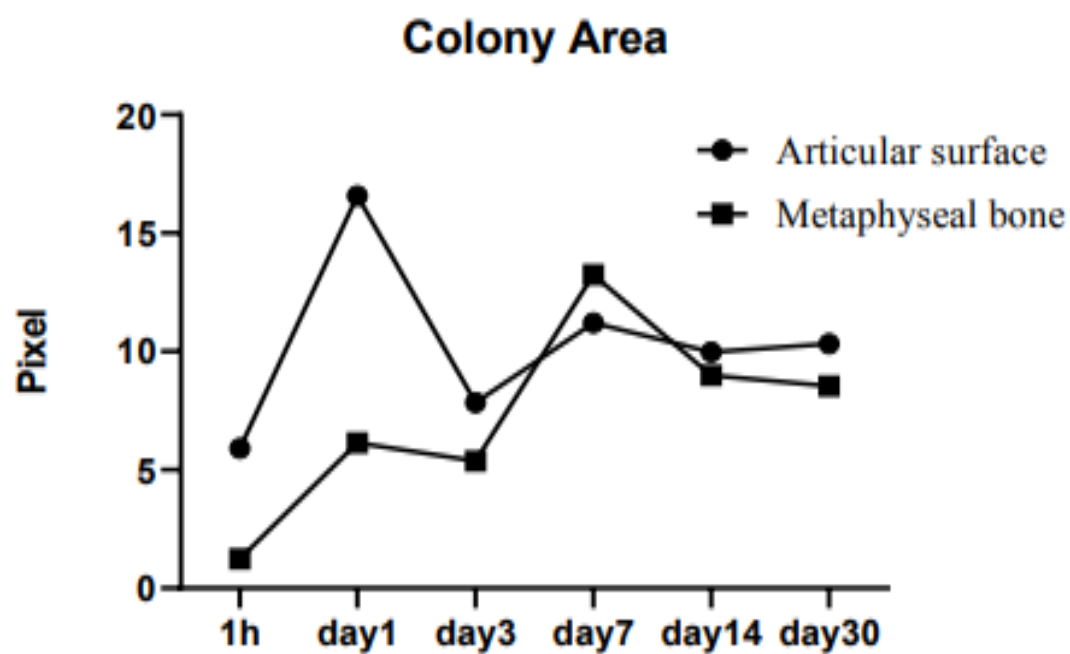


Fig 1. Bacteria distribution Region of colonies in the articular surface area was the biggest in day 1 after inoculation. Region of colonies in the metaphyseal bone area increased from 7days.

ID: 17**Direct antimicrobial activity of WLBU2 against *S. aureus* biofilms is enhanced in physiologic buffered saline**

Jonathan Mandell, John Koch, Kenneth Urish

Background / Rationale: Periprosthetic joint infection of total knee arthroplasties represents a major challenge to the field of orthopaedic surgery. These infections are commonly associated with antibiotic-tolerant *S. aureus* biofilms. An infected total knee arthroplasty, termed periprosthetic joint infection, occurs in 1.5-2% of patients undergoing joint replacement surgery. The engineered cationic amphipathic peptide WLBU2 has shown the ability to kill antibiotic-resistant pathogens and drug-tolerant bacterial biofilms.

Study Question: What is the optimal irrigation solvent conditions using the antimicrobial peptide WLBU2 for direct treatment of *S. aureus* biofilms?

Methods: *S. aureus* mature biofilms were grown on metal implant material and treated with WLBU2 dissolved in differing washout solvents (normal saline, lactated ringers, and dPBS) for 10 minutes. Additionally, pH and ionic strength were manipulated by addition of acid, base, or NaCl to dPBS before *S. aureus* biofilm treatment. Mature biofilms were grown on Kirschner wire implant pieces and placed in the knee joint space of mice, and two days later were removed and placed in WLBU2 dissolved in dPBS with differing pH for 10 minutes of treatment.

Results: Normal saline with a measured pH of 5.8 displayed nearly 99% reduction in bacterial biofilm CFUs with WLBU2 at 62-1000 µg/ml. In comparison, Lactated ringers and dPBS with pH of 6.5 and 7.0 respectively displayed over 99.9% reduction in bacterial biofilm with WLBU at 62-1000 µg/ml. We observed a clear reduction in contact time needed to obtain a three-log reduction as the pH was increased to more alkaline conditions. At 1.0 mg/ml WLBU2 in 6.5 pH PBS needed 15 minutes to achieve a three-log reduction while WLBU2 in 8.0 pH PBS only needed 2.5 minutes. WLBU2 activity could be decreased in hypertonic dPBS and increased in hypotonic dPBS. WLBU2 in hypotonic dPBS of 0.08 M needed only 2.5- 5 minutes to obtain a three-log reduction and 0 CFU sterile samples compared to hypertonic dPBS. WLBU2 dissolved in less acidic dPBS displayed increased efficacy in treating PJI washout murine model.

Discussion: WLBU2 displays the ability to quickly eliminate PJI associated *S. aureus* biofilms on arthroplasty material

Conclusion: The efficacy of engineered cationic amphipathic peptide WLBU2 for intraoperative sterilization of *S. aureus* biofilms can be further optimized when kept in a less acidic and more physiologic pH adjusted saline.

ID: 18**A distinctive release profile of vancomycin and tobramycin from a new and injectable polymeric dicalcium phosphate dehydrate cement (P-DCPD)**

Emily Ren, Weiping Ren, Rahul Vaidya, Paul Begeman, Angelica Guardia

Background / Rationale: Novel injectable polymeric dicalcium phosphate dehydrate (P-DCPD) cement was developed with superior mechanical strength, anti-washout and sustained drug delivery as compared to calcium phosphate cements (CPCs).

Study Question: To assess performance of P-DCPD loaded with vancomycin (VAN-P), tobramycin (TOB-P), and combination vancomycin-tobramycin (VAN/TOB-P).

Methods: Evaluating the drug release profiles, zone of inhibition (ZOI) of *S. aureus* growth and effects on the growth and toxicity of osteoblastic MC3T3 cells. The impact of antibiotic loading on the injectability, setting time and mechanical strength were also evaluated.

Results: There is a distinctive release profile between VAN and TOB. VAN-P showed a slower initial burst and sustained VAN release. However, >90% of VAN was released within 3 days in the presence of TOB (VAN/TOB-P, $p < 0.05$). Very limited TOB release was found both in TOB-P (<5%) and in TOB/VAN-P (<1%) over 28 days. ZOI showed that loaded VAN and TOB maintained bactericidal activity. Eluents collected from VAN-P had stronger and longer ZOI (28 days) compared to TOB-P (14 days, $p < 0.05$). Direct contact of VAN-P, TOB-P and VAN/TOB-P displayed persistent ZOI for > 3 weeks. Interestingly, the cement residues (28 days after drug release study) maintained strong ZOI. Antibiotic-loaded P-DCPD were nontoxic and had no inhibition on growth of MC3T3 cells. VAN-P and TOB-P were injectable. No significant influence on setting time was observed in both VAN-P and VAN/TOB-P as compared to control (16 min). TOB-P slightly increased the compressive strength (60.11 ± 0.22 MPa) as compared to control (53.09 ± 8.64 MPa).

Discussion: A distinctive release profile of VAN and TOB observed is mainly due to different distribution pattern of VAN and TOB within P-DCPD. Very limited TOB release might be due to the incorporation of TOB inside the crystalline lattice of DCPD crystals, so the TOB release mainly relied on the slow P-DCPD degradation rather than diffusion. The bactericidal efficacy of antibiotics-loaded P-DCPD cement is not only depend on the amount and velocity of antibiotics released, but also on the direct contact of bacteria on the degrading cement's surface.

Conclusion: Fully degradable and injectable P-DCPD represents an effective antibacterial strategy to combat orthopaedic infections because of its comparable handling, mechanical strength and favorable cellular response.

3.5 Agar plate zone inhibition of bacterial growth (time course)

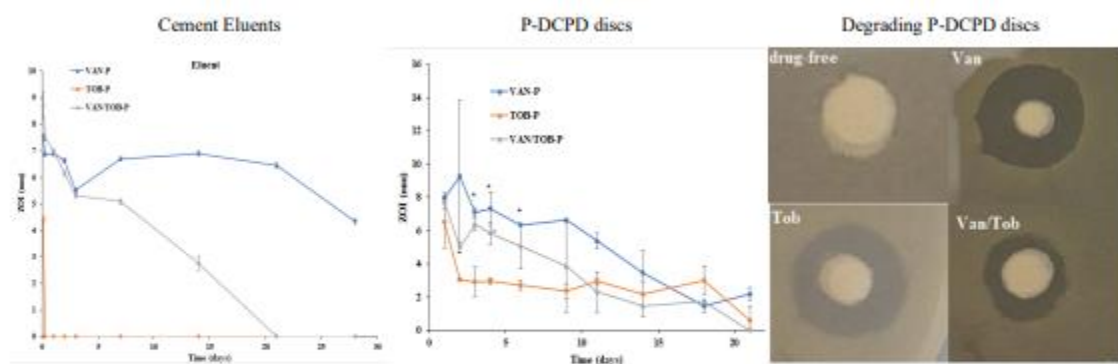


Figure 4. Measuring bactericidal efficacy of antibiotics-loaded P-DCPD cements via zones of inhibition (ZOI) over a period of 22 days. A) Measuring ZOI using eluents collected at given time points over 28 days ($n=3$ for each time points for individual samples); B) ZOI assay using antibiotics-loaded cement discs (before drug eluting study) for up to 22 days ($n=3$ for each time points for individual samples), and C) ZOI assay using degrading cement disc residue (28 days after drug eluting study when majority of embedded antibiotics were released) ($n=2$ for each formula of degrading cements). * $p < 0.05$. Images are representative photographs of the ZOI observed for degrading cement disc residues on agar plates. Assays were performed in triplicate, and data are expressed as the means of 3 data points with standard error bars.

ID: 26

Efficacy of Various Surgical Irrigation Solutions Against Established Biofilm: A Comparative in vitro Investigation

Jeongeun Cho, Karan Goswami, Kamolsak Sukhonthamarn, Javad Parvizi, William Arnold

Background / Rationale: The efficacy of irrigation solutions in removing microbial contamination of a surgical wound, and reducing the rate of surgical site infection (SSI), has been demonstrated extensively. However, it is unknown if irrigation solutions have any activity against established biofilm. This issue is pertinent as successful management of patients with periprosthetic joint infection (PJI) includes the ability to remove biofilm established on the surface of implants and necrotic tissues

Study Question: This study evaluated the efficacy of various irrigation solutions in eradicating established biofilm in a validated in vitro model

Methods: Established biofilms of *Staphylococcus aureus* and *Escherichia coli* were exposed to different irrigation solutions that included Polymyxin 500,000U/L plus bacitracin 50,000U/L, Vancomycin 1g/L, Gentamicin 80mg/L, Normal saline 0.9%, off-the-shelf Betadine 0.3%, Chlorhexidine 0.05%, Benzalkonium 1.3g/L, Sodium hypochlorite 0.125%, and Povidone-iodine 0.5%. Each experiment was conducted in a 96-well microtiter plate with a peg lid and standardized per the MBEC assay manufacturer's protocol. Following 2 minutes of solution exposure, residual biofilms were recovered by sonication. Outcome measures for antibiofilm efficacy were residual colony forming units (CFU) and optical density (690nm). Experiments were conducted in 24 replicates and the observations recorded by two blinded observers

Results: Povidone-iodine 0.5%, Betadine 0.3%, Benzalkonium 1.3g/L, and Sodium hypochlorite 0.125% were significantly more efficacious against *S.aureus* biofilm versus all other solutions. Against *E.coli* biofilm, Povidone-iodine-0.5%, Benzalkonium-1.3g/L and Sodium hypochlorite-0.125% were also most effective compared to other solutions. Polymyxin-bacitracin, Gentamicin, Vancomycin, and Saline solutions had minimal activity against both *E.coli* and *S.aureus* biofilms. Similar trends were observed using both experimental endpoints (CFU and Turbidity) and both investigators

Discussion: Topical antibiotic solutions do not have any activity against established biofilms. Irrigation solutions containing adequate amount of povidone-iodine, betadine, sodium hypochlorite, and benzalkonium appear to have activity against established biofilm by gram positive and gram negative organisms

Conclusion: The use of these irrigation solutions may need to be considered in patients with established PJI

Inhibition of Angiotensin Converting Enzyme Impairs Anti-Staphylococcal Immune Function in a Preclinical Model of Implant Infection

Rishi Trikha, Danielle Greig, Benjamin Kelley, Zeinab Mamouei, Troy Sekimura, Nicolas Cevallos, Nicholas Bernthal

Background / Rationale: Evidence suggests the renin-angiotensin system (RAS) plays key immunomodulatory roles. In particular, angiotensin-converting enzyme (ACE) has been shown to play a role in antimicrobial host defense. ACE inhibitors (ACEi) and angiotensin receptor blockers (ARB) are some of the most commonly prescribed medications, especially in patients undergoing invasive surgery.

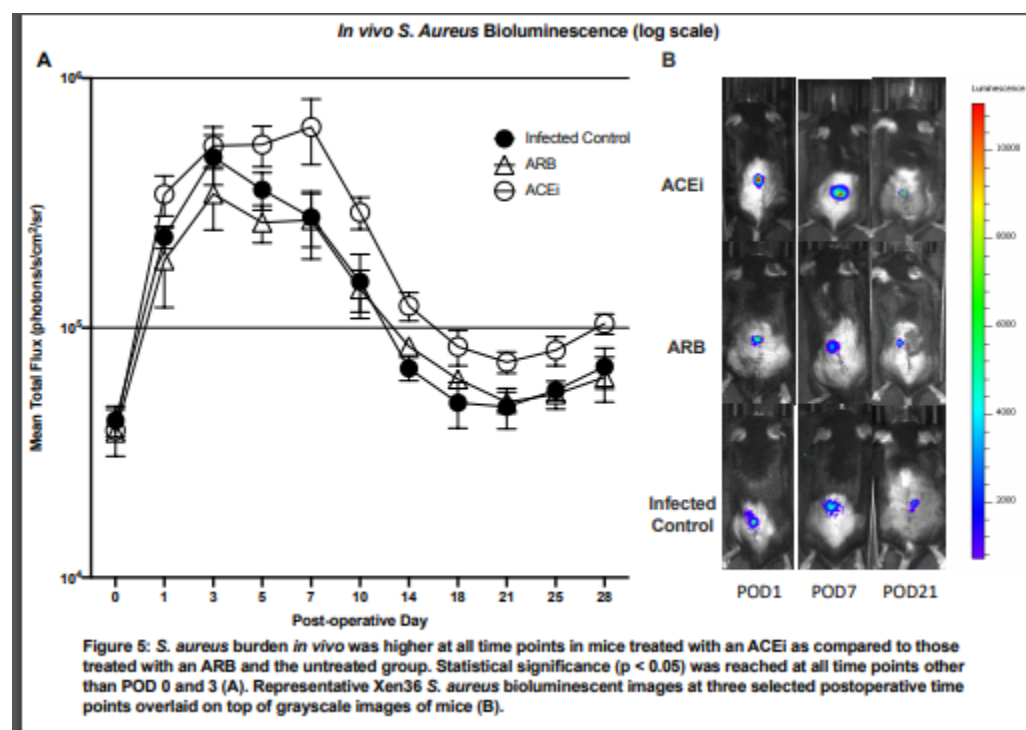
Study Question: The current study aimed to assess if and how the purported immunomodulatory effect of RAS-modulation affected infectious burden in a preclinical model of implant infection.

Methods: In vitro antimicrobial effects of ACEi and ARBs were first assessed. C57BL/6J mice subsequently received either an ACEi (lisinopril; 16mg/kg/day), an ARB (losartan; 30mg/kg/day), or no treatment. Conditioned mice blood was then utilized to quantify respiratory burst function as well as Staphylococcus aureus Xen36 burden ex vivo in each treatment group. S. aureus infectious burden for each treatment group was then assessed in vivo using a validated mouse model of implant infection. Real-time quantitation of infectious burden via bioluminescent imaging over the course of 28 days post-procedure was assessed. Host response via monocyte and neutrophil infiltration within paraspinal and spleen tissue was quantified by immunohistochemistry for F4/80 and myeloperoxidase, respectively.

Results: Blood from mice treated with an ACEi demonstrated a decreased ability to eradicate bacteria when mixed with Xen36 as significantly higher levels of colony forming units (CFU) and biofilm formation was appreciated ex vivo ($p < 0.05$). Mice treated with an ACEi showed a higher infection burden in vivo at all times ($p < 0.05$) and significantly higher CFUs of bacteria on both implant and paraspinal tissue at the time of sacrifice ($p < 0.05$ for each comparison). There was also significantly decreased infiltration and respiratory burst function of immune effector cells in the ACEi group ($p < 0.05$).

Discussion: These results suggest that perioperative ACEi use may represent a previously unappreciated risk factor for surgical site infection. Given the relative interchangeability of ACEi and ARB from a cardiovascular standpoint, this risk factor may be modifiable.

Conclusion: ACEi, but not ARB, treatment resulted in increased S. aureus burden and impaired immune response in a preclinical model of implant infection.



Local Antibiotic Delivery via Calcium Sulfate for Orthopaedic Infections

Daniel Driscoll, Daniel Driscoll, Kathleen Turajane, Ajay Premkumar, Xu Yang, Andy Miller, Mathias Bostrom, David Wellman, Alberto Carli, Ashley Levack

Background / Rationale: There has been increasing interest for using synthetic absorbable calcium sulfate (CaSO₄) as a carrier for local antibiotic delivery to treat orthopaedic infections. However, evidence for guiding the selection of antibiotic and dosing within CaSO₄ remains restrictive.

Study Question: The purpose of this study is determine if antibiotics in addition to vancomycin and tobramycin, specifically dalbavancin, cefazolin, amikacin, minocycline, meropenem and fosfomycin, can reliably elute at bactericidal levels from CaSO₄.

Methods: Synthetic 4.8mm CaSO₄ beads were created in a commercially available bead mold. Beads contained 2.5% to 5% of each antibiotic by weight (2.5% was used if 5% antibiotic beads would not solidify at ambient conditions). Beads were placed individually into Eppendorf tubes containing phosphate buffered saline and placed in a shaking incubator at 37°C to simulate in vivo conditions. The eluent (buffer solution with antibiotic emitted from the CaSO₄ bead) was harvested after 1 hour, 4 hours, 24 hours, 48 hours, 7 days, 14 days, 21 days and 28 days of incubation. The antibiotic concentration at each time point was measured using high performance liquid chromatography coupled with mass spectrometry to calculate hourly elution rates. Elution rates were compared to the minimum inhibitory concentration (MIC) for three bacterial isolates: *S. Aureus*, *E. Coli*, and *A. Baumannii* as determined by baseline broth-micro dilution assay testing.

Results: CaSO₄ beads demonstrated burst release kinetics. Vancomycin, dalbavancin, cefazolin and minocycline had elution rates greater than *S. Aureus* MIC for at least 7 days. Additionally, minocycline demonstrated elution rates greater than the *E. Coli* MIC for 7 days and greater than the *A. Baumannii* MIC for 28 days. Table 1 demonstrates the last timepoint for each antibiotic at which hourly elution rates remained at or above the MIC for three bacteria of interest: *S. aureus*, *E. coli*, and *A. baumannii*.

Discussion: This study evaluated the in vitro elution characteristics of eight antibiotics from CaSO₄ using quantitative methods. Vancomycin, dalbavancin, minocycline and cefazolin eluted concentrations were sufficient to achieve *S. aureus* bacterial inhibition for 7 days. Minocycline and meropenem had sustained elution rates above the MIC values for the tested gram-negative bacteria at 48 hours.

Conclusion: This study provides novel data regarding the elution of several antibiotics from CaSO₄ beads.

Table 1: Last time point at which antibiotic elution rate ($\mu\text{g/mL/hr}$) remains above baseline MIC for each antibiotic-isolate combination

	<i>S. aureus</i>	<i>E. coli</i>	<i>A. baumannii</i>
Vancomycin (5% by dry weight)	7 days	N/A [†]	N/A [†]
Dalbavancin (5% by dry weight)	28 days	N/A [†]	N/A [†]
Cefazolin (2.5% by dry weight)	7 days	48 hours	N/A [*]
Tobramycin (2.5% by dry weight)	24 hours	24 hours	24 hours
Amikacin (2.5% by dry weight)	24 hours	24 hours	24 hours
Minocycline (5% by dry weight)	14 days	7 days	28 days
Meropenem (5% by dry weight)	48 hours	48 hours	48 hours
Fosfomycin (5% by dry weight)	48 hours	N/A [*]	N/A [*]

* MIC above clinically useful value indicating organism resistance to antibiotic

[†]MIC testing not performed due to historical lack of efficacy for antibiotic-organism combination

Thermal Stability and In Vitro Elution Kinetics of Alternative Antibiotics when used in Polymethylmethacrylate (PMMA) Bone Cement

Alberto Carli, Kathleen Turajane, Xu Yang, Andy Miller, Mathias Bostrom, David Wellman, Ashley Levack

Background / Rationale: Amikacin, meropenem, minocycline, and fosfomycin are often utilized clinically to treat multidrug-resistant gram-negative infections. Unfortunately, their suitability for use in polymethylmethacrylate (PMMA) is poorly understood.

Study Question: The purpose of this study is to (1) quantify the thermal stability of these antibiotics using a PMMA bead model and (2) determine elution kinetics for beads of different sizes.

Methods: Polymerization temperatures of 10mm PMMA beads were measured to generate a simulated heating curve. Aqueous solutions of tobramycin, amikacin, meropenem, minocycline, and fosfomycin were subjected to the simulated temperatures followed by incubation at 37°C. Minimum inhibitory concentrations (MIC) of each antibiotic were evaluated against *S. Aureus*, *E. Coli* and *A. Baumannii* using a broth micro-dilution assay. High-dose 4.5mm, 6mm and 10mm antibiotic-laden PMMA beads (10% antibiotic by weight) were created, submerged individually in Phosphate-buffered saline, and incubated at 37°C. Antibiotic elution was determined using high performance liquid chromatography coupled with mass spectrometry. Antimicrobial efficacy after elution was also tested.

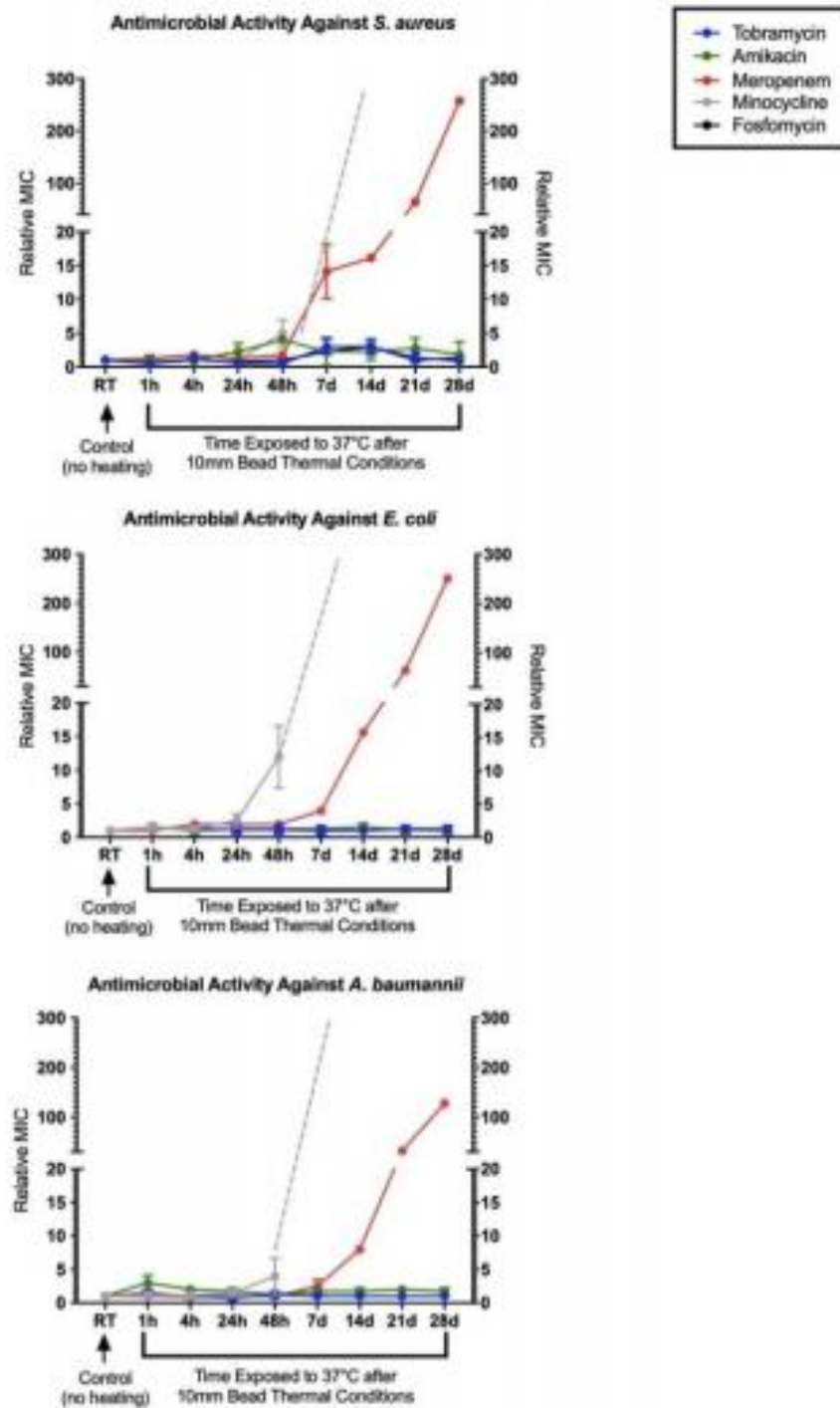
Results: Tobramycin, amikacin and fosfomycin demonstrated thermal stability and maintained antimicrobial activity for 28 days. Minocycline and meropenem lost antimicrobial activity against all three organisms after 48 hours and 7 days respectively. Hourly elution rates of tobramycin and amikacin remained above or near the MIC for gram-negative isolates for 24 hours, while meropenem and minocycline were above MIC for 48 hours. Fosfomycin did not reach the MIC for any isolate. MIC testing after elution mirrored the thermal testing results for *E. Coli*.

Discussion: This study identified notable differences in thermal stability and elution among antibiotics used to treat gram-negative infections. Amikacin exhibited thermal stability and elution kinetics similar to tobramycin. Meropenem out-performed tobramycin and amikacin in terms of elution kinetics, and demonstrated thermal stability in the 7-day period over which elution occurs above the MIC for the antibiotic-organism combinations tested.

Conclusion: Amikacin and meropenem may be acceptable alternatives for local delivery in PMMA for treatment of severe multidrug-resistant gram-negative infections.

Figure 1: Thermal stability experiment

Relative change in MIC after exposure to simulated thermal conditions. MIC data at each time point is normalized to room temperature baseline control samples, reflecting a percent change from baseline.



Polymicrobial Synergy: *Staphylococcus aureus* - *Candida albicans* Coinfection Increases Colonization and Antibiotic Resistance

Zeinab Mamouei, Benjamin Kelley, Nicolas Cevallos, Ameen Chaudry, Nicholas Bernthal

Background / Rationale: Polymicrobial implant-associated infections (IAIs) are increasing in incidence and portend worse clinical outcomes compared to monomicrobial IAIs. However, the reasons underlying this difference are poorly understood, including interactions between the most common bacterial and fungal pathogens *Staphylococcus aureus* (SA) and *Candida albicans* (CA). To address this gap, we investigated how co-incubation of SA and CA influences colonization and antibiotic sensitivity in an in vitro model of IAI.

Study Question: How does co-incubation of SA+CA impact implant colonization?
How does co-incubation of SA+CA impact SA antibiotic susceptibility?

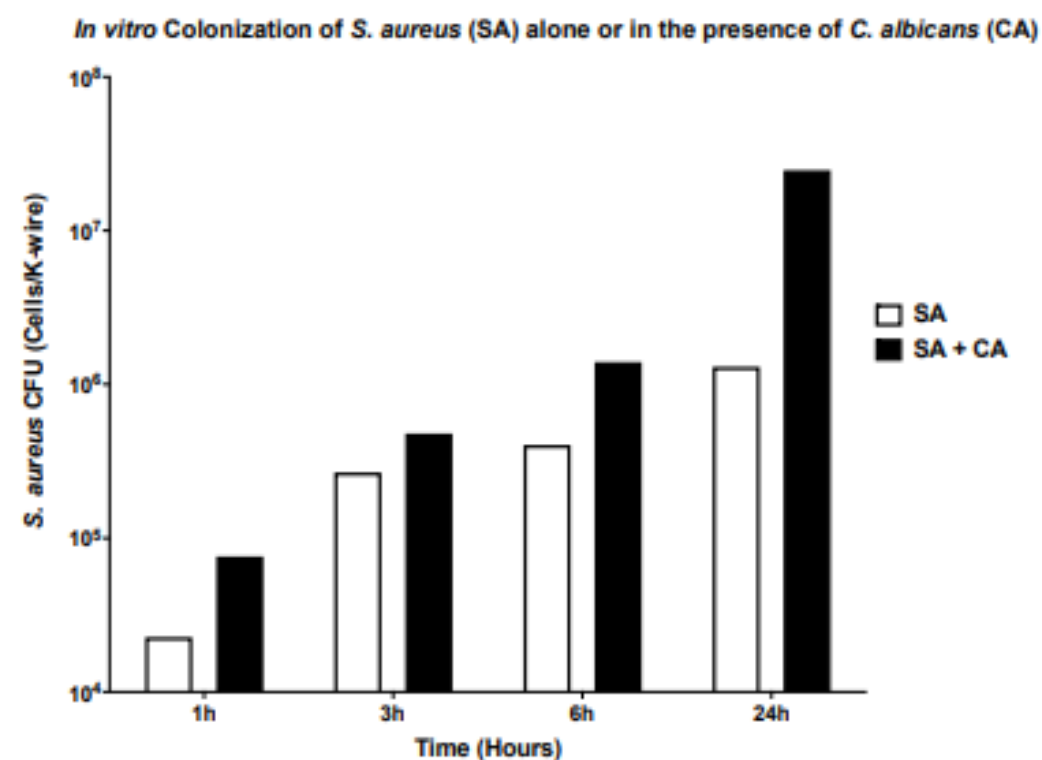
Methods: In vitro, stainless-steel K-wires were inoculated with one of the following conditions: (1) sterile control (2) SA (3) co-incubation SA+CA. The SA inoculum was 5×10^7 CFU/mL and the CA inoculum was 5×10^6 CFU/mL. Following an initial 1-hour incubation to establish biofilm, K-wires were transferred to fresh RPMI for subsequent 1-, 3-, 6-, and 24-hour incubations. At these timepoints, K-wires were removed, and adherent biofilm was removed by sonication, and measured with CFU counting, quantified as cells per K-wire.

To study the effect of SA+CA co-incubation on SA antibiotic susceptibility, a minimum inhibitory concentration (MIC) assay was performed using vancomycin. Inocula of 10^6 cells/well of SA and 10^5 cells/well of CA.

Results: Co-incubation of SA with CA demonstrated significantly higher CFU/k-wire of SA compared to SA alone at all timepoints (Figure 1A). In addition, SA+CA co-incubation resulted in a dramatic 3-fold reduction in SA vancomycin susceptibility (Figure 1B).

Discussion: Polymicrobial SA+CA demonstrated higher CFU of SA across all timepoints and reduced vancomycin susceptibility compared to monomicrobial SA control. This SA-CA synergy reflects the clinical challenge posed by polymicrobial IAIs. SA-CA synergy may hold clinical significance as a mechanism of antibiotic resistance in polymicrobial IAIs. Further investigation is required to understand the mechanisms underlying SA-CA synergy and to optimize treatment. In particular, given the increased virulence and antibiotic resistance of polymicrobial IAIs, 2-stage protocols may be favored over DAIR.

Conclusion: Co-incubation of SA with fungal pathogen CA increases implant colonization and antibiotic resistance of this bacterial pathogen.

Figure 1A**Figure 1B**

Minimum Inhibitory Concentration (MIC) Assay:
 Vancomycin Susceptibility of *S. aureus* (SA) + *C. albicans* (CA) Colncubation

	MIC (µg/ml)
SA	800
SA + CA	>3200

In Vitro Analysis of Anti-Biofilm Effect of Intraoperative Irrigation Solutions

Ajay Premkumar, Sita Nishtala, Mathias Bostrom, Alberto Carli, Ajay Premkumar

Background / Rationale: A diverse array of antibacterial solutions are utilized by orthopedic surgeons in an attempt to disperse bacterial biofilm. These solutions vary significantly in their cost and toxicity profile. To date, there are very few studies that compare these agents, including antibiotics and surfactant-based products, against biofilm grown on clinically relevant orthopedic surfaces.

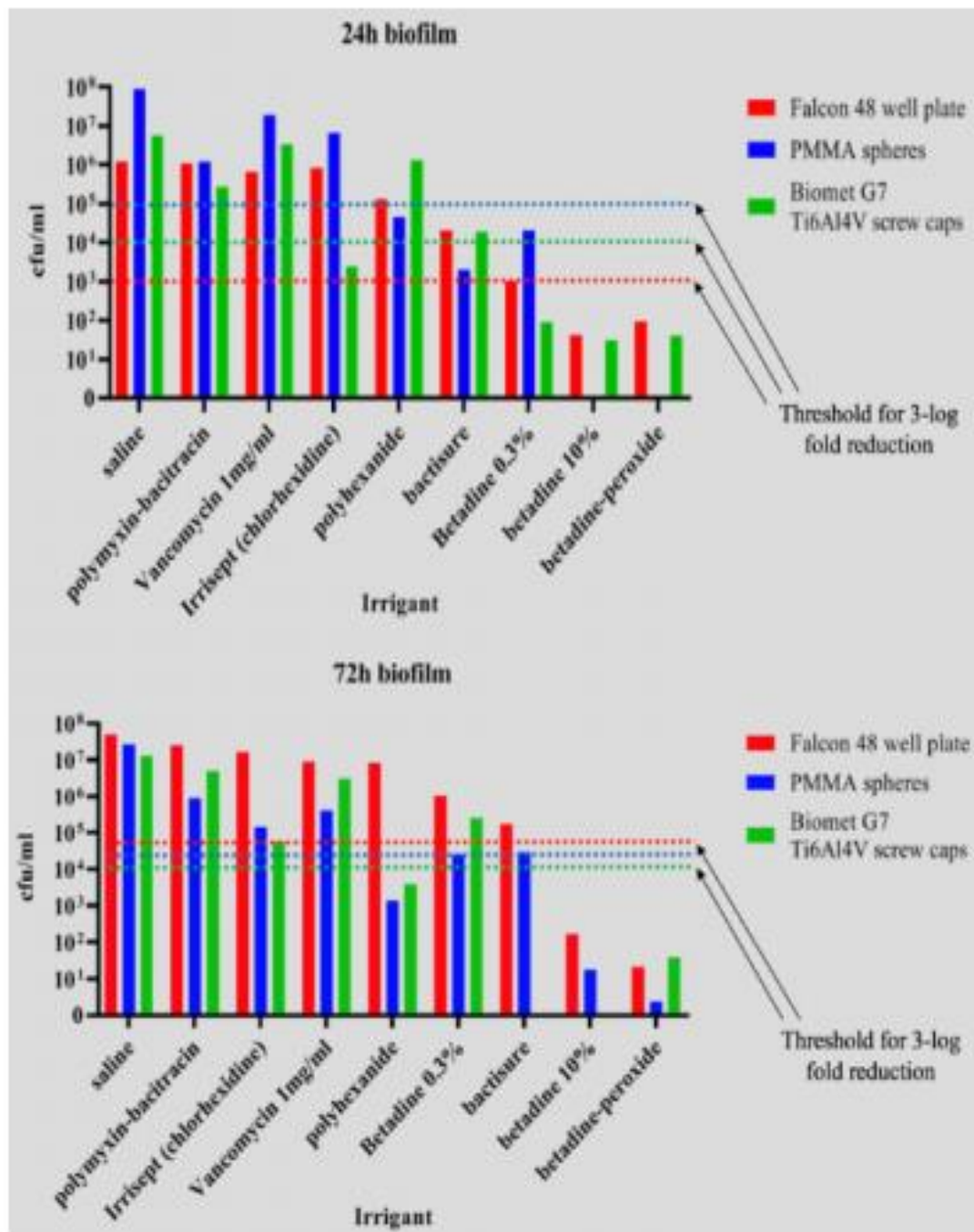
Study Question: What is the in-vitro effect of commercially available intraoperative antibacterial solutions against biofilm-based Methicillin-sensitive Staphylococcus aureus (MSSA) growing on plastic, cement and porous titanium?

Methods: MSSA derived from a clinical isolate (Xen36, Perkin Elmer) was utilized. Three clinically relevant materials were chosen to establish biofilm: plastic Falcon® 48-well plates, polymethylmethacrylate cement beads (Simplex P; Stryker) and grit blasted Ti-6Al-4V acetabular screw caps (G7; Zimmer-Biomet). Antibacterial solutions included: isotonic saline, vancomycin (1mg/mL), diluted polymyxin-bacitracin (500,000 U/L – 50,000 U/L, respectively), povidone-iodine 0.3%, povidone-iodine 10%, a 1:1 combination of povidone iodine 10% & 4% hydrogen peroxide, Irrisept® (Irrimax) , Prontosan® (B.Braun), and Bactisure® (Zimmer-Biomet). Antibacterial solutions were tested according to manufacturer specifications/guidance. 24 hour and 72 hour Xen36 biofilms were exposed to antibacterial solutions for 3 minutes to reproduce intraoperative conditions. Solution efficacy was measured through sonication of treated surfaces followed by counting colony forming units (CFUs). Experiments were performed in triplicate and repeated at least once. A three-fold log reduction in CFU counts versus controls was considered as a measure of solution efficacy.

Results: Povidone-iodine 10% and povidone-iodine + peroxide were the only effective solutions across all three surfaces (Figure 1). Bactisure was effective against 24-hour biofilm grown on cement and titanium, and only titanium at 72 hours. Irrisept was effective against biofilm grown on titanium for 24 hours.

Discussion: Commercial antibacterial solutions vary significantly in their efficacy against MSSA biofilm. Efficacy globally decreased as biofilm maturity increased. Increased solution cost did not confer increased efficacy.

Conclusion: Povidone-iodine 10% and povidone-iodine 10% + hydrogen peroxide are the most consistently effective solutions for MSSA biofilm dispersal on several orthopedic surfaces.



ID: 92

Spatial distributions of cytokines in chronic localized infections

Taylor Shackelford, Nicole Prince, Jonathan Boyd, Julia Penatzer, Matthew Dietz

Background / Rationale: Systemic cytokine concentrations in chronic infection have been extensively studied, improving clinical diagnostics. However, less is known about the spatial relationships of cytokines with respect to proximity to infection.

Study Question: The aim of this study was to define the spatial gradients of cytokines in a chronic joint infection to determine differences in cytokine concentrations across spatial gradients, and identify localized infection-dependent cytokine markers on a tissue level

Methods: Using a rodent model of periprosthetic joint infection (PJI), animals were treated with retrograde femoral intramedullary K-wire insertion and subsequent knee infection with methicillin sensitive *Staphylococcus aureus*. Three surgical treatments were performed with six rats per group: a sham surgery (no implant/ no infection); implant only (implant/no infection); and infected implant (implant/infection). Bone and tissue samples were collected from 4 distinct locations: at the operative knee; 1.5 cm proximal to operative knee; 1.0 cm distal from operative knee; and at the contralateral knee. The concentrations of IL-1 α , IL-1 β , IL-4, IL-5, IL-6, IL-10, IL-12p70, IL-13, GM-CSF, IFN- γ , and TNF- α were quantified in each sample relative to volume. Cultures from taken from all limbs for speciation and colony forming unit (CFU) analysis.

Results: At 21 days post-operatively tissue and radiographic findings coincided with the culture positive rate of 2.36×10^5 CFU/g in the infected group. Higher concentrations of eight cytokines were seen in the implant only and infection groups' operative limbs when compared to uninfected limbs, with at-knee and distal samples having higher levels than proximal tissue. Additionally, IL-1 β , IL-4, and IL-6 were significantly increased in infected limbs compared to uninfected.

Discussion: Spatial differences exist surrounding inflamed joints, with cytokine concentrations of implanted rats being highest at the knee joint and distal to it. Four cytokines are upregulated in the setting of infection, functioning as a clinical marker for infected tissue in the setting of PJI.

Conclusion: Tissue-level analysis may provide additional advantages over systemic markers for PJI management.

ID: 111

Minimum Biofilm Eradication Concentration of Caspofungin against Candida and Aspergillus

Jessica Burns, Rex Moore, Paulo Castaneda, Derek Overstreet, Alex McLaren

Background / Rationale: Fungal infections involving orthopaedic implants form biofilms with antifungal tolerance similar to bacterial biofilms. Treatment principles for implant-related fungal infections are similar to treatment of implant-related bacterial infections: complete surgical debridement, high-dose local antifungals to kill any retained biofilm and delayed reconstruction. Caspofungin is an antifungal with activity against azole resistant candida and aspergillus species, and release of caspofungin from acrylic bone cement has been reported to be high. However, the tissue levels of caspofungin needed to kill sessile fungi in biofilms (minimum biofilm eradication concentration - MBEC) is unknown.

Study Question: What is the MBEC for caspofungin against representative species of azole resistant candida and aspergillus?

Methods: Fungal biofilms of *Aspergillus Fumigatus* (ATCC 96918), *Candida Parapsilosis* (ATCC 22019) and *Candida Albicans* (ATCC 14053), were grown on muscle and bone, in static culture for 24 hours at 37°C, confirmed with crystal violet and, exposed to serial concentrations of caspofungin 31, 62.5, 125, 250, 500, 1000, 2000, 4000, 8000 µg/mL for 6, 24, and 72 hours, then washed and subcultured for 21 days. The lowest caspofungin concentration that resulted in no growth on subculture was defined as the MBEC for the respective fungi.

Results: MBEC for Caspofungin decreased with antifungal exposure time for the two candida species studied and ranged from 2000 µg/mL for *C Parapsilosos* on bone with 6hr exposure to 500 µg/mL for *C Albicans* on muscle with 72hr exposure. MBEC for *A Fumigatus* was above 8000 µg/mL, the maximum level studied, for all conditions.

Discussion: These data are important information to guide formulation of locally delivered antifungals. High reported caspofungin release and similarity in solubility properties to soluble antibacterials like tobramycin suggest that local caspofungin levels might be similar to local antibacterial tissue levels from local delivery in acrylic bone cement. For example, 1000 µg/mL caspofungin tissue levels for 24hr duration is likely achievable clinically. Therefore, caspofungin delivered from acrylic bone cement could achieve the levels needed to kill the two candida species studied in biofilm

Conclusion: The MBEC for *C albicans* and *C Parapsilosis* on muscle and bone is 500-1000 µg/ml with 24hr exposure. *A Fumigatus* in biofilm is tolerant to 8000 µg/mL under all conditions we studied.

ID: 111

Fungi	Tissue	MBEC (ug/mL)		
		6hr	1 day	3 day
Aspergillus Fumigatus 96918	Bone	>8k	>8k	>8k
	Muscle	>8k	>8k	>8k
Candida Parapsilosis 22019	Bone	2000	1000	1000
	Muscle	2000	500	500
Candida Albicans 14053	Bone	1000	500	500
	Muscle	500	500	500

SYMPOSIUM #3

“Extended Use of Antibiotics for Prophylaxis and Treatment after Orthopaedic Surgery”

Moderator: Thorsten Seyler, MD

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Session III

Clinical Research

Moderator: Brian Klatt, MD; Gina Suh, MD

The CRIME80 Predicts Failure of Debridement, Antibiotics, and Implant Retention (DAIR) for Total Hip and Knee Arthroplasty Acute Hematogenous Periprosthetic Joint Infection

Brian Chalmers, Milan Kapadia, Y-fen Chiu, Andy Miller, Michael Henry, Alberto Carli

Background / Rationale: Debridement, antibiotics, and implant retention (DAIR) remains the gold standard for acute hematogenous periprosthetic joint infection (PJI) after total hip (THA) or knee (TKA) arthroplasty. However, there is a high rate of failure, up to 25-70% in some series. As such, algorithms have been developed to predict DAIR failure.

Study Question: What is the predictive value of the CRIME80 (CRP $\geq$ 150 mg/L, COPD, RA fracture as Indication, Male, not Exchanging the mobile components, and age above 80 years), compared to comorbidity scoring indices, namely the Charlson comorbidity index (CCI), Elixhauser comorbidity index (ECI), and McPherson classification, in predicting DAIR failure for acute hematogenous PJIs.

Methods: We identified 143 patients undergoing a DAIR for an acute hematogenous PJI with <4 weeks of symptoms after a THA (55, 39%) or TKA (88 patients, 62%). Mean age was 61 years and mean body mass index (BMI) was 31 kg/m². Seventeen patients (12%) failed at 90 days and 35 (25%) failed at 2 years defined as repeat surgery for PJI. We utilized a univariate regression analysis to identify predictors of DAIR failure. We calculated a receiver operator curve (ROC) and the area under the curve (AUC) to better understand the predictive value of the KLIC, ECI, CCI, and McPherson host grade for DAIR failure. We calculated an optimal cutoff using a Youden's J index.

Results: In the univariate analysis, the CRIME80 as a continuous variable predicted DAIR failure at 90 days ($p=0.004$) and 2 years ($p=0.02$). However, the CCI ($p=0.53$), ECI ($p=0.7$), and McPherson classification ($p=0.31$) were not predictive of DAIR failure. In a univariate approach, 90-day and 2-year AUC was 0.70 and 0.61 for the CRIME80. With a multivariate analysis controlling for age, sex, and BMI, the CRIME80 AUC improved to 0.77 at 90 days. The optimal CRIME80 score cutoff for failure at 90 days was ≥ 1 .

Discussion: In this series of patients undergoing DAIR or acute hematogenous PJI, the CRIME80 score reliably predicted DAIR failure, especially at 90 days. While other studies have suggested a cutoff of ≥ 3 , a CRIME80 of ≥ 1 was highly predictive of failure at 90 days.

Conclusion: In this series of patients undergoing DAIR or acute hematogenous PJI, the CRIME80 score reliably predicted DAIR failure. A CRIME80 of ≥ 1 was highly predictive of failure at 90 days.

The KLIC Did Not Predict Failure of Debridement, Antibiotics, and Implant Retention (DAIR) for Total Hip and Knee Arthroplasty Acute Postoperative Periprosthetic Joint Infection

Brian Chalmers, Milan Kapadia, Yu-fen Chiu, Andy Miller, Michael Henry, Alberto Carli

Background / Rationale: Debridement, antibiotics, and implant retention (DAIR) remains the gold standard for acute postoperative periprosthetic joint infection (PJI) after total hip (THA) or knee (TKA) arthroplasty. However, the failure rate of DAIR is high, ranging from 25-70% in some series.

Study Question: The goal of the current study was to compare the predictive value of a new scoring system for acute postoperative PJIs, the KLIC (Kidney Failure, Liver Failure, Index surgery, Cemented prosthesis, and CRP), versus comorbidity scoring indices, namely the Charlson comorbidity index (CCI), the Elixhauser comorbidity index (ECI), and the McPherson host.

Methods: We identified 147 patients undergoing a DAIR for an acute postoperative PJI <90 days from THA (63 patients, 43%) or TKA (84 patients, 57%). Mean age was 64 years and mean body mass index (BMI) was 31 kg/m². Ninety-four (64%) of patients had a primary TKA or THA while 53 patients (36%) had a revision. Forty-one patients (28%) failed at 90 days and 56 (38%) failed at 2 years, defined as repeat PJI surgery. We utilized a univariate regression analysis to identify predictors of DAIR failure at 90 days and 2 years. We also calculated a receiver operator curve (ROC) and the area under the curve (AUC) to better understand the predictive value of these scoring systems.

Results: For univariate analysis, KLIC ($p=0.87$), CCI ($p=0.13$), ECI ($p=0.46$), and the McPherson classification were not predictive of DAIR failure at 90 days or 2 years. In a univariate approach, 90-day and 2-year AUC was 0.51 and 0.54 for the KLIC, 0.57 and 0.56 for the CCI, 0.52 and 0.50 for the ECI, and 0.57 and 0.56 for the McPherson host grade, respectively. For multivariate analysis controlling for age, sex and BMI, no AUCs for any of these predictors at 90 days or 2 years were above 0.66, suggesting that no scoring system served as a reliable predictive measures.

Discussion: Although validated in other series', the KLIC had no value in predicting DAIR failure for acute postoperative PJI in our patient population at 90 days or 2 years.

Conclusion: The KLIC had no value in predicting DAIR failure for acute postoperative PJI in our patient population at 90 days or 2 years.

ID: 55**Results of Irrigation and Debridement for PJI with the Use of Intraosseous Antibiotics**

Beau Kildow, Shaun Patel, Jesse Otero, Keith Fehring, Brian Curtin, Bryan Springer, Thomas Fehring

Background / Rationale: Debridement, Antibiotics and Implant Retention (DAIR) remains the norm for the treatment of acute periprosthetic joint infection (PJI) despite less than optimal success rates. Intraosseous (IO) administration of vancomycin has been shown to have significantly increased local bone and tissue concentrations compared to systemic antibiotics, with lower systemic antibiotic levels compared to intravenous.

Study Question: The purpose of this study was to evaluate if the addition of IO regional antibiotics to our protocol at the time of DAIR would improve outcomes.

Methods: A retrospective review of 35 PJI TKA patients who underwent DAIR combined with IO vancomycin (500mg) was performed with minimum 12-month follow-up. 26 patients were treated for acute perioperative or acute hematogenous infections following primary TKA. Nine were treated for chronic infections with components that were considered unresectable (ie) constructs with ingrown cones, sleeves, or long cemented stems in elderly comorbid patients. Primary outcome was defined by no reoperations for infection nor clinical signs or symptoms of PJI.

Results: The average follow up for acute infection was 16.5 months (range 12.1-24.2) and 15.8 months (range 12-24.8) for chronic infections with unresectable components. Overall eradication rates for acute infection was 93.1% while only 44.4% for chronic infections with unresectable components. MSIS host grade was a significant indicator of failure ($p < 0.001$).

Discussion: The use of IO vancomycin at the time of DAIR yielded improved results compared to standard irrigation and debridement in acute periprosthetic infections. Its use in chronic infections should remain cautious. While these results are encouraging, this technique requires longer follow-up before widespread adoption.

Conclusion: The use of IO vancomycin at the time of DAIR yielded improved results compared to standard irrigation and debridement in acute periprosthetic infections.

Deep infection after distal radius open-reduction internal fixation.

Tyler Henry, Richard McEntee, Jonas Matzon, Pedro Beredjiklian, Kevin Lutsky

Background / Rationale: Given its low incidence, there is a paucity of information regarding the optimal management of deep infection following distal radius open-reduction internal fixation (ORIF). Similarly, the impact of deep infection on overall outcomes after distal radius ORIF is underreported. In an effort to expand our current understanding, the purpose of this case series is to present the treatment courses and outcomes of patients treated for deep infection after distal radius ORIF.

Study Question: What are the outcomes of utilized treatment strategies for deep infection after distal radius ORIF?

Methods: All patients with deep infections after distal radius ORIF over a ten-year period were identified. Their electronic medical records were thoroughly reviewed and their treatment courses and outcomes described.

Results: In our series, the incidence of deep infection was approximately 0.1%. The cohort of patients treated for deep infection consisted of three women and one man with an average age of 56 years (Table 1). All four patients were treated with surgical irrigation and debridement (I&D) with removal of hardware (ROH) and a course of antibiotics. Mean time from infection presentation to I&D with ROH was 16 days (Range: 3 – 44 days). The identified bacterial species in all cases was *Staphylococcus aureus* (MRSA = 2, MSSA = 2). Three patients were treated with intravenous antibiotics (2 Vancomycin, 1 Cefazolin), while one patient was treated with oral antibiotics (Cephalexin). Mean time from infection presentation to final clinical follow-up was 11 months (Range: 3 – 20 months). Two patients required repeat I&D. A clinical determination of successful infection eradication was made in all cases. Final functional outcome scores were available for three patients and were 36 (DASH), 35 (DASH), and 34 (Quick-DASH), respectively.

Discussion: Deep infection after distal radius ORIF is a rare occurrence for which there is little data on treatment strategies and outcomes. Our treatment involved surgical I&D with ROH, and post-operative antibiotics. Although this did result in eradication of the infections in all patients, functional deficits did persist, as reflected by final DASH scores.

Conclusion: Deep infection after distal radius ORIF can be successfully treated with I&D, ROH, and a prolonged course of antibiotics. Acceptable outcomes are achievable but functional deficits after treatment may occur.

Characteristic	Range
Age	36 – 74 years old
Body Mass Index	26 – 36
Time from ORIF to Infection Presentation	5 days – 5 months
Time from Infection Presentation to I&D	3 – 44 days
Duration of Post-operative Antibiotics	4 – 8 weeks
Number of Patients	
Current Tobacco Users	1
Dominant-sided Fractures	2
Presenting Symptom	
Skin changes	3
Altered Mental Status	1
ESR Obtained at Infection Presentation	2 (Both WNL)
Radiographic Changes at Infection Presentation	1 (Screw Displacement)
Bacterial Species	
MSSA	2
MRSA	2
Route of Post-operative Antibiotics	
Intravenous	3
Oral	1
Type of Postoperative Antibiotics	
Vancomycin	2
Cefazolin	1
Cephalexin	1
Repeat I&D Required	2

Table 1. Descriptive characteristics of the study cohort. ESR = Erythrocyte sedimentation rate, WNL = Within normal limits, MSSA = Methicillin-sensitive *Staphylococcus aureus*, MRSA = Methicillin-resistant *Staphylococcus aureus*.

ID: 59

Infection Rates Associated with Immediate Use Steam Sterilization

Alex Demers, Thomas Moran, Joseph Park

Background / Rationale: Immediate Use Steam Sterilization (IUSS) is widely used for maintaining operating room efficiency through the rapid sterilization of contaminated equipment needed for urgent use in orthopaedic surgery. However, its expanded role for the sterilization of complete surgical trays and routine processing of items contradicts Center for Disease Control and the Association of periOperative Nurses guidelines due to the potential risk of postoperative infection and complications. This has led institutions to adopt policies that have reduced and even prohibited IUSS despite limited and contradictory data.

Study Question: Is the implementation of IUSS associated with an increased incidence of postoperative infection, complications, or need for revision surgery in comparison to obtaining a new equipment tray?

Methods: Retrospective chart review was performed to identify orthopaedic surgery cases with a sterility event at an academic hospital over a six-month period. Events were stratified by execution of IUSS or acquisition of a new equipment tray. Two years postoperatively, patient charts were queried to identify the incidence of postoperative infection, follow-up complication, or need for revision surgery. Descriptive statistics, chi-squared tests ($\alpha=.05$), and odds ratios (OR) were performed for all variables.

Results: 77 cases with a sterility event were identified. When IUSS was utilized ($n=10$), there was no significant association with the development of an infection at follow up ($p=1.000$) or need for revision surgery (OR 3.611, CI [.30-43.98], $p=.345$). IUSS, however, did correlate with an increased risk of follow-up complications (OR 6.79, CI [1.25-36.52], $p=.043$).

Discussion: The absence of an association for IUSS with postoperative infection and revision surgery provides affirmative evidence supporting the safety and efficacy of IUSS in orthopaedic surgery. Despite an increased risk of complications with IUSS, previous literature suggests that this association may be linked to the complexity inherent to patients with preoperative morbidity and risk factors that contribute to increased IUSS usage. The findings of this retrospective study provide an important addition to the limited literature examining IUSS in orthopaedic surgery.

Conclusion: The results from this study illustrate that IUSS is not associated with an increased risk of infection or revision surgery, but is associated with an increased risk of complications following orthopaedic surgery.

Table 1. Association of IUSS with Postoperative Outcomes

	New Tray	IUSS	P-value	Odds Ratio (95% CI)
Total Cases	67	10	-	-
Follow Up Complication	4	3	.043*	6.79 (1.25-36.52)
Follow Up Infection	3	0	1.000	-
Revision Surgery	2	1	.345	3.611 (.30-43.98)
Total Complications	10	3	.359	2.443 (.54-11.03)

Does performing total joint arthroplasty in the afternoon or evening increase the risk of prosthetic joint infection?

Ibrahim Tuncay, Orkhan Aliyev, Faith Yildiz

Background / Rationale: The literature contains little data on the relationship between the time of arthroplasty during the day and the risk of subsequent periprosthetic joint infection (PJI).

Study Question: 1. Does performing total joint arthroplasty in the afternoon or evening increase the rate of early prosthetic joint infection?
2. Does performing total joint arthroplasty after 14:01 increase the likelihood of early prosthetic joint infection?

Methods: We evaluated patients retrospectively, who underwent primary total hip (THA) or knee arthroplasty (TKA) between January 2016 and December 2019, met the inclusion criteria, and had at least 90 days of follow-up. Patients were divided into two groups. Group I consisted of patients whose surgeries had been started and finished before 14:00, and group II included patients whose surgeries started after 14:01. All patients were operated after non-septic cases in specific orthopedic operating rooms. Their demographic data and comorbidities were noted. The primary outcome was to compare the risk of PJI between the groups.

Results: Group I and group II included 2309 and 1881 patients. The total number of patients with the diagnosis of PJI was 58(1.4%). It was 31(1.3%) and 27(1.4%), respectively ($p = 0.79$). Performing total joint arthroplasty after 14:01 did not increase the likelihood of infection ($p=0.83$, OR, 1.03). Among the parameters, PJI was significantly associated with age ($p<0.01$, OR, 0.99), smoking status ($p<0.01$, OR, 0.15) and operating time ($p=0.04$, OR, 0.99) in TKA and with direct anterior approach ($p=0.02$, OR, 4.72) in THA. Age ($p=0.06$, OR, 1.03) was the factor affecting the risk of subsequent PJI after total joint arthroplasty.

Discussion: We did find that age, smoking status, operation time, and type of approach in THA were associated with an increased risk of PJI, as reported elsewhere.

We found that performing a TJA in the afternoon or evening does not increase the risk of PJI, supporting the previous study (i.e., case order is not a significant risk factor for increased PJI).

Conclusion: Performing total joint arthroplasty in the afternoon or in the evening, after aseptic cases do not increase the risk of subsequent of PJI.

ID: 64

Antibiotic Stewardship Interventions Significantly Improve Preferred Antibiotic Prophylaxis in Elective Primary Total Joint Arthroplasty

Raquel Roberts, Katelyn Quartuccio, Jessica Stern, Eric Heintz, Kelly Pillinger, Thomas Myers

Background / Rationale: Most patients reporting a penicillin (PCN) allergy can tolerate PCN and cephalosporin antibiotics. Cephalosporins are the preferred prophylaxis in a total joint arthroplasty (TJA). The purpose of this study was to evaluate appropriate prophylaxis in patients with a reported PCN allergy undergoing a TJA following antibiotic stewardship intervention.

Study Question: We hypothesized that patients reporting PCN allergies would receive preferred prophylaxis more often following stewardship intervention that included updates to institutional guidelines (definitions) and processes. Only one other study has investigated this question, with this method, in this patient population.

Methods: A retrospective case-control included patients with a documented PCN allergy who underwent a TJA at our institution from March 1, 2017 to August 30, 2017 (pre-intervention) and from March 1, 2019 to August 30, 2019 (post-intervention). The primary outcome was the difference in the composite rate of the following: 1) patients with a reported non-severe PCN allergy without MRSA risk factors who received cefazolin 2) patients with a non-severe PCN allergy with MRSA risks factors who received cefazolin plus vancomycin, and 3) patients with a severe PCN allergy who received vancomycin prior to a primary TJA following stewardship intervention. A power analysis revealed 90 patients per group was required to detect a 20% difference with 80% power ($p < 0.05$).

Results: At the time of the procedure, 90 patients in the pre-intervention group and 90 patients in the post-intervention group had a documented PCN allergy. Post-intervention revealed a significant increase in the primary outcome of appropriate peri-operative antibiotic (54.5% vs 90.8%, $P < 0.001$) use. No patients had signs of an allergic reaction thought to be due to cefazolin.

Discussion: The remarkable increase in the overall use of the preferred peri-operative antibiotic for a TJA was likely a result of reclassification of hives/local swelling as a non-severe reaction in combination with provider education and standardization of antibiotic ordering across all surgeons.

Conclusion: Implementing antibiotic stewardship at a major tertiary academic center increased preferred prophylaxis in elective primary TJA. Patients with non-severe PCN allergies, even those reporting hives or local swelling can tolerate cefazolin without any issues.

Antibiotic Usage Before and After Stewardship Interventions

Peri-operative Antibiotic ^a	Pre-intervention (n=90)	Post-intervention (n=90) ^a	P-value ^{b,c}	
Cefazolin	47 (52.2)	83 (92.2)	<0.0001	Fisher's
Vancomycin	43 (47.8)	14 (15.6)	<0.0001	Fisher's
Clindamycin	9 (10.0)	1 (1.1)	0.01816	Fisher's
Appropriate antibiotic				
Composite	49/90 (54.4)	79/87 (90.8)	<0.0001	χ^2
Non-severe allergy	36/76 (47.4)	73/76 (96.1)	<0.0001	χ^2
Severe allergy	9/14 (64.3)	6/11 (54.5)	0.6968	Fisher's
Inappropriate antibiotic				
Non-severe allergy				
Clindamycin	4 (4.4)	0	0.12	Fisher's
Vancomycin	25 (27.8)	0	<0.0001	Fisher's
Vancomycin + clindamycin	5 (5.6)	0	0.0584	Fisher's
Cefazolin + vancomycin	2 (2.2)	2 (2.3)	1.00	Fisher's
(without MRSA risk factors)				
Cefazolin monotherapy (with MRSA risk factors)	0	1 (1.1)	1.00	Fisher's
Severe allergy				
Cefazolin	4 (4.4)	2 (2.3)	0.6609	Fisher's
Vancomycin + clindamycin	1 (1.1)	1 (1.1)	1.00	Fisher's
Cefazolin + vancomycin	0	2 (2.3)	0.1833	Fisher's
Appropriate antibiotic timing	33 (36.7)	41 (45.6)	0.2889	Fisher's
Appropriate antibiotic dosing	85 (94.4)	89 (98.9)	0.2108	Fisher's
Appropriate antibiotic timing and tourniquet TKA	0/16 (0)	12/13 (92.3)	<0.0001	Fisher's
Post-operative antibiotics				
None	2 (3.3)	0	0.4972	Fisher's
≤24 hours	85 (94.4)	89 (98.9)	0.2108	Fisher's
>24 hours	3 (3.3)	1 (1.1)	0.6208	Fisher's
Tolerability of cefazolin				
Signs of an allergic reaction within 72 hrs.	0/47	2/83 (2.4)	0.5348	Fisher's
Itching	N/A	2 (100)	N/A	
Received diphenhydramine	N/A	0	N/A	
Tryptase level drawn	N/A	0	N/A	
Reaction thought to be from cefazolin	N/A	0	N/A	
Cefazolin added as allergy in chart	N/A	0	N/A	

^a All statistics are expressed as n (%) unless otherwise stated.

^b P < 0.05 by Fisher's exact or chi-squared for categorical variable or Mann-Whitney U test for continuous variables, respectively.

^c Normally distributed continuous variables were analyzed with a two-group t test.

^d Multiple allergy types were reported by some patients with non-severe allergies

^e Allergy was de-labeled by AIR in 3 patients in the post-intervention group prior to procedure

KLIC and CRIME80 Do Not Predict DAIR Success for PJI

Christine Wu, Sean Ryan, Zoe Hinton, William Jiranek, Jessica Seidelman, Thorsten Seyler

Background / Rationale: Periprosthetic joint infection (PJI) is a devastating complication following total joint arthroplasty, and the success rate of debridement, antibiotics and implant retention (DAIR) varies. Some investigators have shown that preoperative scores, KLIC and CRIME80, predicted failure rates of DAIR in treating early and late acute PJI, respectively.

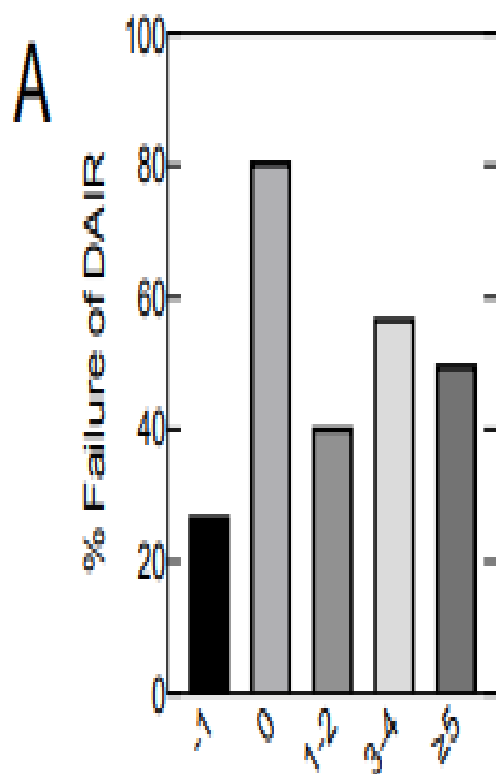
Study Question: Our goal was to investigate the predictive value of KLIC and CRIME80 scores for treatment of early and late acute PJI at a single tertiary referral center, with the hypothesis that these scores would be predictive of likelihood of a successful DAIR.

Methods: Patients treated with DAIR following hip or knee PJI at our institution from April 2005 to March 2019 were retrospectively reviewed. Patients without adequate laboratory data for KLIC or CRIME80 scores were excluded, resulting in 109 early (PJI within 90 days of implantation) and 62 late (PJI more than 90 days after implantation) PJI included for analysis. KLIC or CRIME80 score, result of DAIR, age, and gender were collected. Failure was defined as reinfection or need for additional surgical intervention for PJI. Univariate analyses were performed to assess DAIR failure rates in groups stratified by KLIC (early PJI) and CRIME80 (late PJI) scores.

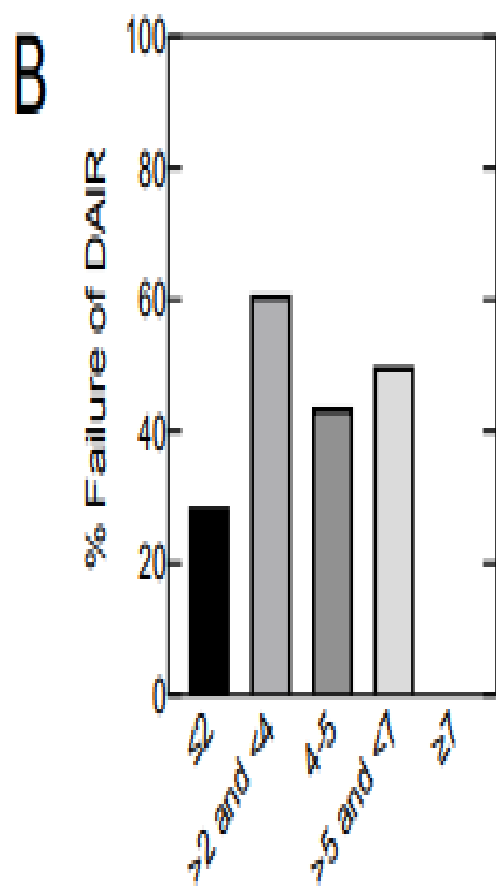
Results: Early PJI patients had a mean age of 63.6 years, were 47.7% female, and had an average KLIC score of 2.9. Late PJI patients had a mean age of 62.3 years, were 38.7% female, and had an average CRIME80 score of 0.7. Failure rates for stratified KLIC scores were: ≤ 2 (27.0%), > 2 and ≤ 4 (80.8%), 4-5 (40.5%), > 5 and ≤ 7 (57.1%), and > 7 (50.0%) (Panel A). KLIC categorical score did not have a predictive effect on DAIR failure. Failure rates for stratified CRIME80 scores were: -1 (28.6%), 0 (60.9%), 1-2 (43.8%), 3-4 (50.0%), ≥ 5 (0%) (Panel B). CRIME80 categorical score did not have a predictive effect on DAIR failure.

Discussion: In our patient population, KLIC and CRIME80 scores, stratified in the same manner as previous studies, were not predictive of DAIR failure. For both early and late PJI, there was no difference in age, gender, or KLIC and CRIME80 stratified scores between patients who had failed or successful DAIR.

Conclusion: This study suggests that additional investigation is needed to determine preoperative factors that may predict the likelihood of successful DAIR in the treatment of early and late acute PJI.



Categorical KLIC Score



Categorical CRIME80 Score

ED Utilization in TJA: Analysis of PICC Readmissions

Zoe Hinton, Sean Ryan, Christine Wu, Jessica Seidelman, William Jiranek, Thorsten Seyler

Background / Rationale: The incidence of prosthetic joint infection (PJI) following total joint arthroplasty (TJA) has increased over time to at least 2% in 2009. Outpatient parenteral antibiotic therapy is increasingly utilized in the management of orthopaedic-related infections as most patients are prescribed postoperative intravenous antibiotics whether they receive a debridement, antibiotics, and implant retention (DAIR), one-stage, or two-stage revision arthroplasty.

Study Question: We sought to investigate complications related to peripherally-inserted central catheters (PICC) following TJA at our institution.

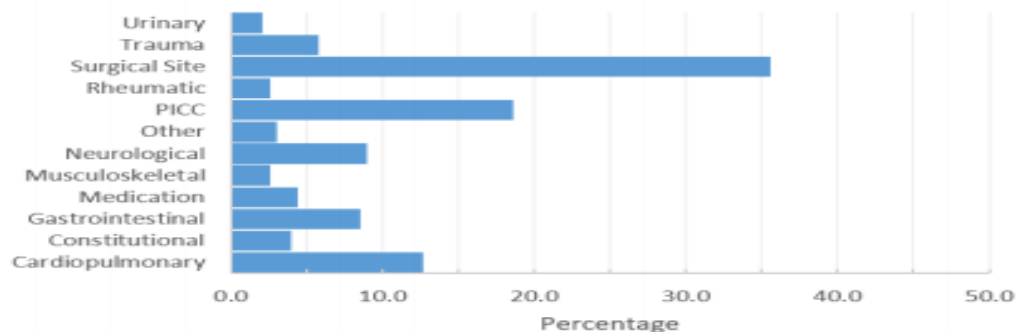
Methods: We completed a retrospective review of the institutional database for total hip arthroplasty (THA) and total knee arthroplasty (TKA) patients from January 2005 through October 2019 that developed a PJI and required PICC placement. Patient demographics including age, gender, ASA score, and comorbidities were collected, as well as 90-day emergency department (ED) visits, reoperations, and revisions.

Results: 437 patients (45.8% female) with a mean age of 63.9 years (range 30.5-88.7) were included in the study population. Index operations included 176 THA and 265 TKA that were revised for PJI. The cohort had 143 90-day ED visits (32.7%) with 27 (18.8%) PICC-related. There were a total of 157 (33.7%) readmissions with only 1 readmission being PICC-related. In the THA cohort, smoking ($p=0.016$) and COPD ($p=0.036$) were significantly associated with PICC ED visit. In the TKA cohort, rheumatoid arthritis ($p=0.004$) was significantly associated with a non-PICC ED visit and COPD ($p=0.008$) was significantly associated with a PICC ED visit. A multivariable logistic regression model controlling for age, gender, ASA, comorbidities, THA, and TKA demonstrated that COPD (OR 3.67, 95% CI 1.25-10.77; $p=0.018$) was the only variable associated with PICC-related ED visits. There were 218 distinct primary reasons for the 143 ED visits.

Discussion: PICC complications were relatively common within the PJI cohort at our institution occurring at a rate of 18.8% of all 90-day ED visits.

Conclusion: This high level of utilization represents a potential area of targeted healthcare delivery reform for PJI patients in order to decrease health care expenditure.

Primary Reasons for 90 Day ED Visits



ID: 69

Decreased 90-Day Surgical Site Complication Rates with Closed Incision Negative Pressure Therapy after Revision Knee Arthroplasty: A Randomized Trial

Ahmed Emara, Herbert Cooper, Michael Cross, George Guild, Denis Nam, Giles Scuderi, Fred Cushner, Ronald Silverman, Carlos Higuera Rueda

Background / Rationale: Surgical site complications (SSC) are pervasive in high-risk revision total knee arthroplasty (rTKA), and there are several postoperative wound care modalities to mitigate this risk

Study Question: This randomized clinical trial investigated 90-day 1) incidence of SSCs; 2) health care utilization; and 3) patient-reported outcomes (PRO) in high-risk rTKA patients with postoperative closed incision negative pressure wound therapy (ciNPT) vs. standard of care (SOC) silver-impregnated occlusive dressing

Methods: 294 rTKA patients at high-risk for wound complications were randomized to SOC or ciNPT (n=147 each) and stratified by revision type (aseptic vs. septic). The ciNPT suction system was adjusted at 125mmHg. Treatment duration was 25 days and outcomes were assessed until 90 days. SSC rates were assessed using intention to treat (ITT) and modified ITT analyses. Healthcare utilization and PRO were assessed using ITT

Results: 242 patients completed follow-up (ciNPT:124 (84.4%); SOC:118 (80.3%)). Demographics, comorbidities, revision causes, and treatment duration were similar between arms ($p>0.05$). ITT analysis showed lower SSC rates with ciNPT vs. SOC ($p=0.001$). Similar outcomes were obtained with the modified ITT analysis (ciNPT:4% (5/125) vs. SOC:16.4% (21/128); OR:0.22, 95%CI[0.08, 0.59]; $p=0.001$).

ciNPT cohort had lower readmission rates ($p=0.02$), and number of dressing changes ($p<0.001$).

There was no significant difference between ciNPT and SOC in 90-day postoperative improvement of Knee injury and Osteoarthritis Outcome Score Quality of Life ($p=0.751$), Sports and Recreation ($p=0.143$), Activities of Daily Life ($p=0.215$), and pain ($p=0.371$) subdomains, nor Patient-Reported Outcomes Measurement Information System Global-10 Mental ($p=0.971$) and Physical Health scores ($p=0.278$)

Discussion: ciNPT was associated with significantly lower 90-day SSC and readmission rates in addition to less frequent dressing changes. Difference in 90-day incidence of SSC subtypes (superficial/deep surgical site infection, wound dehiscence, skin necrosis, seroma/hematoma and continued drainage) was not significant possible due to the rarity of occurrence

Conclusion: ciNPT mitigates 90-day SSC and readmission rates in high risk rTKA patients. Lower frequency of dressing changes within the ciNPT cohort may provide added value for healthcare utilization without compromising pain/function

Table 1. Reported 90-day outcomes among patients receiving standard of care vs. closed incision negative pressure wound therapy (ciNPT) on an intention-to-treat basis.

90-day outcome	ciNPT (n = 147)	SOC (n = 147)	Odds ratio (95% CI)	p-value
Primary Outcomes				
90-day SSC [§] (one patient may experience >1 type of SSCs)	5 (3.4%)	21 (14.3%)	0.22 (0.08, 0.59)	0.0013
SSC types per occurrence				
Any SSI	2 (1.4%)	6 (4.1%)	0.33 (0.07, 1.67)	0.2815
Superficial SSI	1 (0.7%)	3 (2.0%)	0.34 (0.03, 3.27)	0.6221
Deep SSI	1 (0.7%)	3 (2.0%)	0.34 (0.03, 3.27)	0.6221
Full thickness dehiscence	1 (0.7%)	5 (3.4%)	0.20 (0.02, 1.72)	0.2133
Seroma or hematoma requiring drainage	0 (0%)	5 (3.4%)	0.09 (0.05, 1.64)	0.0601
Skin necrosis	0 (0%)	0 (0%)	NE	NE
Continued drainage	2 (1.4%)	7 (4.8%)	0.28 (0.06, 1.38)	0.1721
90-day SSC in the aseptic population	2 (1.8%)	15 (14.3%)	0.11 (0.02, 0.49)	0.0006
90-day SSC in the septic population	3 (10%)	6 (17.6%)	0.63 (0.14, 2.82)	0.7171
Secondary Outcomes				
30-day SCC [§]	4 (2.7%)	19 (12.9%)	0.19 (0.06, 0.58)	0.0014
45-day SCC [§]	4 (2.7%)	21 (14.3%)	0.17 (0.06, 0.50)	0.0004
90-day readmission [§]	5 (3.4%)	15 (10.2%)	0.30 (0.11, 0.86)	0.0208
Related to procedure	4 (2.7%)	6 (4.1%)		
Unrelated to procedure	1 (0.7%)	9 (6.1%)		
LOS if readmitted (days)	2.2 ± 2.28	8.6 ± 7.38		0.0254
Number of clinic visits	0.9 ± 1.2	1.0 ± 1.58		0.9062
Number of home health visits	3.4 ± 6.45	3.6 ± 7.96		0.7875
Number of rehabilitation or physical therapy visits	18.3 ± 14.72	18.0 ± 14.99		0.6884
90-day reoperation if a SSC occurred	1 (0.7%)	4 (2.7%)	0.24 (0.03, 2.21)	0.3707
Dressing changes (within treatment duration)	1.1 ± 0.29 144	1.3 ± 0.96 134		0.0003

SSC: Surgical Site Complications; SSI: Surgical Site Infection; LOS: Length of hospital stay; [§]Number of patients (one patient may experience >1 type of SSCs); CI: Confidence interval.

ID: 70

High Rate of Infection Associated with Arthroscopic Lysis of Adhesions for Arthrofibrosis following Total Knee Arthroplasty

Nathan Thomas, Christina Liu, Nathan Varady, Pierre-Emmanuel Schwab, Yhan Colon Iban, Antonia Chen

Background / Rationale: Arthrofibrosis after total knee arthroplasty (TKA) is often treated by manipulation under anesthesia (MUA) or arthroscopic lysis of adhesions (ALA). Although previous studies have suggested equivocal improvements in range of motion (ROM), treatment decisions are often based on temporal factors and surgical site infection (SSI) rates have not been detailed.

Study Question: 1) Is there a ROM difference between ALA and MUA?, 2) What is the SSI rate following ALA vs MUA?, and 3) What factors are predictive of SSI?

Methods: This retrospective study included 421 patients undergoing ALA or MUA for arthrofibrosis following unilateral, primary TKA from 2001-2017. Demographics (age, race, comorbidities), clinical variables, and SSI, as defined by Centers for Disease Control and Prevention (CDC) criteria, were collected. Demographics and SSI rates were compared using Student's t-test and Kaplan-Meier log rank tests. Multivariable logistic regressions were used for adjusted analysis, and ROM data was analyzed using mixed-effect models; $p < 0.05$ was considered significant.

Results: Patients in the ALA group were younger (55.2 vs 58.9 years, $p < 0.001$) and underwent surgery further from their index TKA (22 vs 3.3 months, $p < 0.001$). Charlson Comorbidity Index ($p < 0.044$) and diabetes were higher in MUA patients ($p < 0.026$). ROM was 68° pre-MUA vs 86° pre-ALA ($p < 0.001$), but did not differ between groups post-procedure (118° vs 117° , $p = 0.27$) or across the 2-year follow-up period. Gains in ROM were equivalent for MUA performed before or after 3 months (118° , $p < 0.001$). ALA patients had significantly more SSIs (3.4%, 7/208) than MUA patients (0.5%, 1/213; $p = 0.027$). Median time to SSI was 1 month (0.33-8.9). Cultured organisms included: MRSA(2), Staph. epidermidis(1), Staph. lugdunensis(1), Strep. mitis(2), and culture negative SSI(1). Neither demographic variables nor comorbidities were predictive of SSI. SSI treatment included I&D/liner exchange(5), one-stage exchange(1), and two-stage exchange(1).

Discussion: This study demonstrated a higher SSI rate following ALA for arthrofibrosis compared to MUA. Neither demographics nor comorbidities predicted infection. Clinical ROM outcomes were equivalent between ALA, MUA, and delayed MUA.

Conclusion: The significantly higher risk of SSI and subsequent operative intervention associated with ALA suggests that MUA should be the preferred treatment for arthrofibrosis after TKA.

ID: 71

Lower Socioeconomic Status is Associated with Increased Risk of Girdlestone Resection Arthroplasty Following Periprosthetic Infection of the Hip

Gregory Kirchner, Alexander Lieber, Yehuda Kerbel, Raymond Kim, Vincent Moretti, Lucas Nikkel

Background / Rationale: Girdlestone resection arthroplasty (GRA) is a radical but sometimes necessary treatment for periprosthetic joint infection (PJI) of the hip. Currently, there is limited knowledge regarding the characteristics of patients that require this drastic procedure to control PJI of the hip.

Study Question: (1) Are there any patient characteristics that are more commonly seen in those who undergo GRA compared to those who do not? (2) Are there any identifiable independent risk factors for GRA in the setting of PJI of the hip?

Methods: This is a retrospective, cross-sectional analysis of the National (Nationwide) Inpatient Sample from 2010 to 2014. The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) was used to identify 27,404 patients with PJI of the hip, including 889 patients who underwent GRA (ICD-9-CM 80.05). A multivariate model was created to examine the association between GRA and patient characteristics such as age, sex, race, primary payer, median household income, and location and teaching status of the hospital where the procedure was performed. Furthermore, the model controlled for patient comorbidities, including diabetes, anemias, hypertension, congestive heart failure, chronic pulmonary disease, peripheral vascular disease, and drug abuse.

Results: The strongest independent risk factor for GRA was Medicare insurance (odds ratio [OR] 1.859, 95% confidence interval [CI] 1.500-2.304). Medicaid insurance was also associated with GRA (OR 1.662, CI 1.243-2.223). Compared to the wealthiest quartile for household income, patients in the poorest quartile (OR 1.299, CI 1.046-1.614) and second-poorest quartile (OR 1.269, CI 1.027-1.567) were significantly more likely to have a GRA. Furthermore, patients greater than 80 years old were at higher risk of GRA than all other age groups. Race and sex were not independent risk factors for GRA.

Discussion: Controlling for multiple patient factors, poorer patients, patients with government-run health insurance plans, and elderly patients are at independently heightened risk of undergoing a GRA for treatment of PJI of the hip. Surgeons should incorporate these risk factors into their decision making for primary and revision hip arthroplasty candidates.

Conclusion: This study demonstrates with lower socioeconomic standing at increased risk of undergoing a GRA for treatment of PJI of the hip.

Adjusted Risk of Girdlestone Resection Arthroplasty (GRA)[‡]

Variable	GRA OR (95% CI)
Payer	
Medicare	1.859 (1.500-2.304)
Medicaid	1.662 (1.243-2.223)
Private insurance	—
Median Income	
Bottom quartile	1.299 (1.046-1.614)
Bottom middle quartile	1.269 (1.027-1.567)
Top middle quartile	1.143 (0.919-1.423)
Top quartile	—
Race	
White	1.206 (0.927-1.569)
Black	1.075 (0.769-1.502)
Other	—
Age Group (years)	
<50	0.657 (0.481-0.898)
50-64	0.720 (0.567-0.914)
65-80	0.569 (0.465-0.698)
>80	—
Sex	
Male	0.871 (0.754-1.006)
Female	—
Hospital Type	
Rural	0.676 (0.493-0.926)
Urban non-teaching	0.730 (0.622-0.858)
Urban teaching	—

[‡]Comorbidities controlled for in multivariate analysis include diabetes, anemia, hypertension, congestive heart failure, chronic pulmonary disease, peripheral vascular disease, and drug abuse. OR, odds ratio. CI, confidence interval.

ID: 75

Surprising Little Impact of Obesity on Outcomes Following 2 Stage Reimplantation Total Knee Arthroplasty for Infection

Yehuda Kerbel, Joseph Koressel, Brian Perez, Ryan DeAngelis, Gwo-Chin Lee

Background / Rationale: There is little information about the impact of obesity on the salvage of the infected TKA.

Study Question: The purpose of this study is to evaluate the rates of 1) reinfection, 2) complications, 3) reoperations, and 4) readmissions in patients with obesity undergoing 2 stage exchange for infected TKA.

Methods: We retrospectively reviewed 247 consecutive patients with infected THA undergoing first time 2 stage exchange. The average body mass index (BMI) was 33.1 kg/m². Patients were divided into I-nonobese (n=86), II- obese (30-39.9 kg/m²) (n=122) and III-morbidly obese (40 kg/m²) (n=39). We compared our endpoints between obese (n=161) and non-obese patients (n=86). Furthermore, to minimize confounding, three propensity score matched cohorts with respect to age, sex, medical comorbidities, smoking and payor status was created to determine the impact of BMI on various outcomes using Chi-squared and Fischer exact tests. The sample size was adequately powered to detect inter-class differences.

Results: The average follow up was 34.5 months (12-85). Patients with obesity (BMI>30) had an increased risk of re-revision (OR 2.64, CI 1.13-6.16) compared to non-obese patients. 36 patients (25 obese) required irrigation and debridement and 8 patients (5 obese) needed flap coverage or skin graft. Comparing the propensity matched cohorts (group I (n=33), II (n=39), III (n=39)), there were no statistical differences regarding reinfection (18% non-obese vs 18% obese, [OR 0.98, CI 0.3-3.28] vs 28% morbidly obese [OR 1.77, CI 0.57-5.45]), complications (36% vs 54% [OR 2.04, CI 0.79-5.27] vs 44% [OR 1.35, CI 0.52-3.50]), reoperations (18% vs 28% [OR 1.77, CI 0.57-5.45] vs 33% [OR 2.25, CI 0.74-6.81]), re-revision (3% vs 10% [OR 3.66, CI 0.39-34.5] vs 8% [OR 2.67, CI 0.26-26.9]), and readmissions (9% vs 5% [OR .54, CI 0.09-3.45] vs 13% [OR 1.47, CI 0.32-6.68]).

Discussion: In a retrospective cohort comparison of patients undergoing 2 stage revision for infected TKA, stratification by BMI demonstrated no increased risk of complication or failure in obese patients.

Conclusion: These counter intuitive results highlight the morbidity of treatment with 2 stage revision for infected TKA irrespective of body weight.

Table 5. Comparison of outcomes as a factor of matched BMI cohort					
	Non-obese	Obese	OR (95% CI)	Morbidly Obese	OR (95% CI)
LOS >3 days	16 (48%)	20 (51%)	1.12 (0.44-2.83)	20 (51%)	1.12 (0.44-2.83)
Complication	12 (36%)	21 (54%)	2.04 (0.79-5.27)	17 (44%)	1.35 (0.52-3.50)
Readmission	3 (9%)	2 (5%)	0.54 (0.09-3.45)	5 (13%)	1.47 (0.32-6.68)
Return to OR [*]	6 (18%)	11 (28%)	1.77 (0.57-5.45)	13 (33%)	2.25 (0.74-6.81)
Reinfection	6 (18%)	7 (18%)	0.98 (0.30-3.28)	11 (28%)	1.77 (0.57-5.45)
Further Revision	1 (3%)	4 (10%)	3.66 (0.39-34.5)	3 (8%)	2.67 (0.26-26.9)
Terminal failure [†]	2 (6%)	4 (10%)	1.77 (0.30-10.3)	2 (5%)	0.838 (0.11-6.30)
Mortality	0	3 (8%)	NR	2 (5%)	NR
OR, odds ratio; CI, confidence interval; LOS, length of stay; OR [*] , operating room; NR, too few cases for comparative statistics					
[†] Includes additional procedures: terminal spacer, fusion, resection arthroplasty, or amputation					

Increasing Complications and Failures with Increasing BMI in Patients Undergoing 2-Stage Exchange for Infected THA

Yehuda Kerbel, Nicolas Pascual-Leone, Ariana Meltzer-Bruhn, Matthew Stein, Gregory Kirchner, Gwo-Chin Lee

Background / Rationale: The association between morbid obesity and infection following total hip arthroplasty (THA) is well established. However, little is known about the impact of obesity on the salvage of the infected THA.

Study Question: The purpose of this study is to evaluate the rates of 1) reinfection, 2) complications, 3) reoperations, and 4) readmissions in patients with obesity undergoing 2 stage exchange for infected THA.

Methods: We retrospectively reviewed 119 consecutive patients with infected THA undergoing first time 2 stage exchange. The mean age was 61 years and average body mass index (BMI) was 32.4 kg/m². Patients were divided into 3 groups (I-nonobese, II- obese (30-39.9 kg/m²) and III-morbidly obese (≥ 40 kg/m²)). We compared our primary variables of interest between obese (n=67) and non-obese patients (n=52). Furthermore, in order to minimize confounding, three propensity score matched cohorts with respect to age, sex, medical comorbidities, smoking and payor status was created to determine the impact of BMI on various outcomes using Chi-squared and Fischer exact tests.

Results: The average follow up was 34 months (12-80). Patients with obesity (BMI ≥ 30) had an increased risk of reinfection (OR 17.3, CI 2.22-135.3) and readmissions (OR 4.71, CI 1.28-17.3) compared to controls. Comparing the propensity matched cohorts (group I (n=20), II (n=21), III (n=21)), morbidly obese patients had higher rates of reinfection (43%) and return to OR (57%) compared to non-obese (0% reinfections, p=0.001; 15% return to OR, p=0.009) and obese patients (10% reinfection, p=0.014; 19% return to OR, p=0.011). Morbidly obese patients also had a significantly higher rate of 30-day readmission compared to non-obese patients (0%, p=0.009).

Discussion: There is an increasing risk of complications and failures with increasing BMI in patients undergoing 2 stage exchange for infected THA.

Conclusion: Our findings indicate that obesity is a significant risk factor for poor outcomes after revision 2 stage THA for infection. The data is supportive of either delaying or avoiding THA in patients with morbid obesity.

Table 5. Comparison of outcomes as a factor of matched BMI cohort			
	Non-obese [†]	Obese	Morbidly Obese
LOS >4 days	7 (35%)	10 (48%)	11 (52%)
Major Complication	10 (50%)	13 (62%)	15 (71%)
Readmission	0	4 (19%)	7 (33%) [*]
Return to OR	3 (15%)	4 (19%)	12 (57%) ^{**}
Reinfection	0	2 (10%)	9 (43%) ^{**}
Further Revision	0	1 (5%)	2 (10%)
GRA, Terminal Spacer or Amputation	0	0	0
Mortality	0	2 (10%)	2 (10%)
LOS, length of stay; OR, operating room; GRA, girdlestone resection arthroplasty [†] Reference group for comparisons [*] p<0.05 compared to non-obese cohort ^{**} p<0.05 compared to non-obese cohort and obese cohort			

Polymicrobial Synergy: *Staphylococcus aureus* - *Candida albicans* Coinfection Increases Colonization and Antibiotic Resistance

Zeinab Mamouei, Benjamin Kelley, Nicolas Cevallos, Ameen Chaudry, Nicholas Bernthal

Background / Rationale: Polymicrobial implant-associated infections (IAIs) are increasing in incidence and portend worse clinical outcomes compared to monomicrobial IAIs. However, the reasons underlying this difference are poorly understood, including interactions between the most common bacterial and fungal pathogens *Staphylococcus aureus* (SA) and *Candida albicans* (CA). To address this gap, we investigated how co-incubation of SA and CA influences colonization and antibiotic sensitivity in an in vitro model of IAI.

Study Question: How does co-incubation of SA+CA impact implant colonization?
How does co-incubation of SA+CA impact SA antibiotic susceptibility?

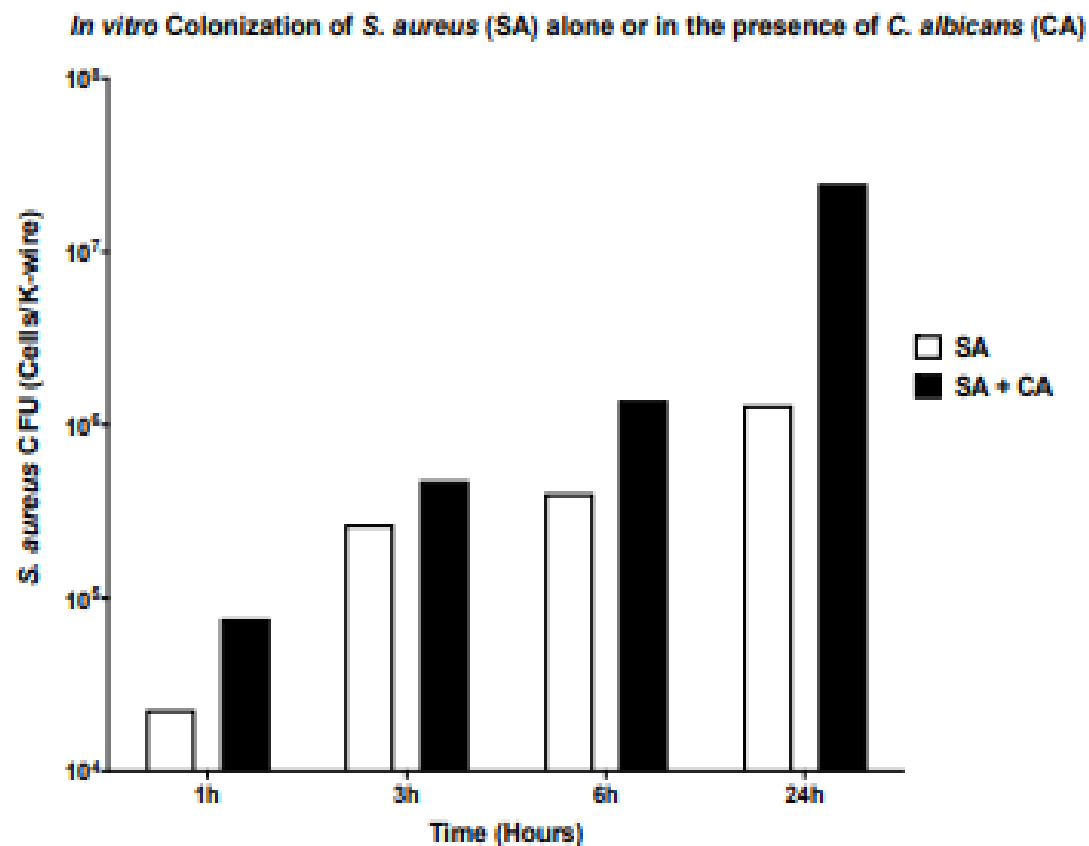
Methods: In vitro, stainless-steel K-wires were inoculated with one of the following conditions: (1) sterile control (2) SA (3) co-incubation SA+CA. The SA inoculum was 5×10^7 CFU/mL and the CA inoculum was 5×10^6 CFU/mL. Following an initial 1-hour incubation to establish biofilm, K-wires were transferred to fresh RPMI for subsequent 1-, 3-, 6-, and 24-hour incubations. At these timepoints, K-wires were removed, and adherent biofilm was removed by sonication, and measured with CFU counting, quantified as cells per K-wire.

To study the effect of SA+CA co-incubation on SA antibiotic susceptibility, a minimum inhibitory concentration (MIC) assay was performed using vancomycin. Inocula of 10^6 cells/well of SA and 10^5 cells/well of CA.

Results: Co-incubation of SA with CA demonstrated significantly higher CFU/k-wire of SA compared to SA alone at all timepoints (Figure 1A). In addition, SA+CA co-incubation resulted in a dramatic 3-fold reduction in SA vancomycin susceptibility (Figure 1B).

Discussion: Polymicrobial SA+CA demonstrated higher CFU of SA across all timepoints and reduced vancomycin susceptibility compared to monomicrobial SA control. This SA-CA synergy reflects the clinical challenge posed by polymicrobial IAIs. SA-CA synergy may hold clinical significance as a mechanism of antibiotic resistance in polymicrobial IAIs. Further investigation is required to understand the mechanisms underlying SA-CA synergy and to optimize treatment. In particular, given the increased virulence and antibiotic resistance of polymicrobial IAIs, 2-stage protocols may be favored over DAIR.

Conclusion: Co-incubation of SA with fungal pathogen CA increases implant colonization and antibiotic resistance of this bacterial pathogen.

Figure 1A**Figure 1B**

Minimum Inhibitory Concentration (MIC) Assay:

Vancomycin Susceptibility of *S. aureus* (SA) + *C. albicans* (CA) Coincubation

	MIC ($\mu\text{g/ml}$)
SA	800
SA + CA	>3200

ID: 80

ASA after total hip and knee arthroplasty can significantly reduce post operative persistent wound drainage

Alisina Shahi, Alec Kellish, Vishavpreet Singh, Ali Oliashirazi

Background / Rationale: Persistent wound drainage (PWD) is one of the major risk factors for periprosthetic joint infections (PJI), arguably the most dreaded complications after a total joint arthroplasty (TJA).

Study Question: What are the rates of PWD amongst TJA patients that received Aspirin (ASA) or Coumadin for postoperative venous thromboembolism (VTE) prophylaxis? Does the type of chemical VTE prophylaxis predispose patients to PJI?

Methods: Retrospective review of 5,516 primary TJAs was performed. Patients with PWD were identified. Chi-square test was used to compare the incidences of PWD, 30-day VTEs, and PJI at 6 months between the ASA and coumadin groups. Additionally, a multivariate regression model was used to identify independent risk factors for PWD using Charlson and Elixhauser comorbidity indexes.

Results: The prevalence of PWD was 6.4% (353/5516). Patients who received ASA had lower incidence of PWD (3.2% versus 8.5%, $p < 0.0001$) while having comparable rates of 30-day VTEs (1.3% versus 1.4%, $p = 0.722$) and PJIs at 6 month (1.8% versus 1.4%, $p = 0.233$) when compared to those that received coumadin. Risk factors for PWD were, diabetes (OR: 19.3; 95% CI: 11.8-23.2), rheumatoid arthritis (OR: 15.3; 95% CI: 10.8-17.2), morbid obesity (OR: 13.2; 95% CI: 9.7-17.5), chronic alcohol use (OR: 3.5; 95% CI: 1.8-5.5), hypothyroidism (OR: 1.9; 95% CI: 1.1-3.2), and coumadin (OR 1.7; 95% CI: 1.2 – 2.2).

Discussion: Based on the findings of this study it appears that Aspirin is associated with significantly lower rates of PWD after TJA when compared to Coumadin while being equally efficacious at prevent VTEs.

Conclusion: Coumadin is an independent risk factor for PWD.

ID: 84

Plasma D-Dimer Does Not Determine the Fate of Reimplantation in Two-Stage Exchange Arthroplasty

Tejbir Pannu, Jesus Villa, Charles Engh III, Brett Levine, Jorge Manrique, Nicolas Piuze, Carlos Higuera Rueda, Aldo Riesgo

Background / Rationale: Multiple serum and plasma D-Dimer thresholds have been recently proposed for improving diagnostic accuracy of periprosthetic joint infection (PJI), but there is paucity of data on their use to decide the proper timing of reimplantation.

Study Question: To determine the optimal diagnostic threshold and accuracy for plasma D-Dimer in predicting failure of reimplantation and to investigate if plasma D-Dimer above this threshold at the time of reimplantation increase the risk of subsequent failure.

Methods: A retrospective review was performed on a consecutive series of 53 patients which had two-stage revisions (cases) for PJI and who had plasma D-Dimer test before reimplantation. Surgeries were performed at two institutions [11/22/2017-to-12/5/2020]. The minimum follow-up was 90 days. Out of 53 patients, one patient did not have a minimum follow-up and was excluded. The remaining 52 patients were analyzed. Surgical success was defined by Delphi criteria: (1) control of infection, as characterized by a healed wound without fistula, drainage, or pain; (2) no subsequent surgical intervention owing to infection after reimplantation; and (3) no occurrence of PJI-related mortality. Receiver operating characteristic (ROC) curve was plotted. The optimal threshold of D-Dimer to predict failure was calculated using Youden Index which was used to categorize cases as either D-Dimer positive (above threshold) or negative (below threshold). Kaplan-Meier survival-analysis with log-rank test and univariate Cox-Regression were performed to evaluate this threshold as a predictor of failure.

Results: The mean follow-up for the entire cohort was 368±147.6 days. With area under the curve of 0.608 in ROC curve analysis, plasma D-Dimer showed low accuracy in predicting failure after reimplantation. The optimal D-dimer threshold for predicting failure was determined to be 3070 ng/ml which demonstrated sensitivity of 87.5%, but low specificity (47.7%) [Table 1]. Based on D-Dimer, no difference was found in failure-free survival after reimplantation ($p=0.927$). Elevated D-Dimer at the time of reimplantation was not a risk factor for failure (hazard ratio [HR], 0.973, $p=0.928$).

Discussion: This data suggests that plasma D-dimer has a poor accuracy to determine failure after reimplantation.

Conclusion: Plasma D-Dimer has no ability to predict the fate of reimplantation in two-stage revision.

Table 1. Accuracy of plasma D-Dimer threshold (3070 ng/ml) in predicting the failure of reimplantation in two-stage exchange arthroplasty.

	Failure [Delphi Criteria] (+)	Failure [Delphi Criteria] (-)	Total
Plasma D-Dimer (-)	1	21	22
Plasma D-Dimer (+)	7	23	30
Total	8	44	

Accuracy = $100 \times 7+21/1+7+21+23=53.8\%$

Sensitivity = $100 \times 7/1+7=87.5\%$

Specificity = $100 \times 21/23+21=47.7\%$

Positive predictive value = $100 \times 7/7+23=23.3\%$

Negative predictive value = $100 \times 21/21+1=95.4\%$

Positive Likelihood Ratio = $0.875/1-0.477=1.67$

Negative Likelihood Ratio = $1-0.875/0.477=0.262$

ID: 85**Impact of joint type on time to aspiration and targeted antibiotic administration in patients with septic arthritis**

Edward Woods III, Dr. Anne Sullivan, Edward Woods III

Background / Rationale: Diagnosis and treatment of infected joints is aided by culture of the causative organism. Accurate identification of the infecting organism(s) and antimicrobial susceptibility facilitates appropriate antibiotic therapy. Specimens are often initially obtained by aspirating the infected joint, which may require image guidance. Due to many factors, aspiration requiring image guidance is sometimes performed after empiric antibiotics are given, which may yield inaccurate results.

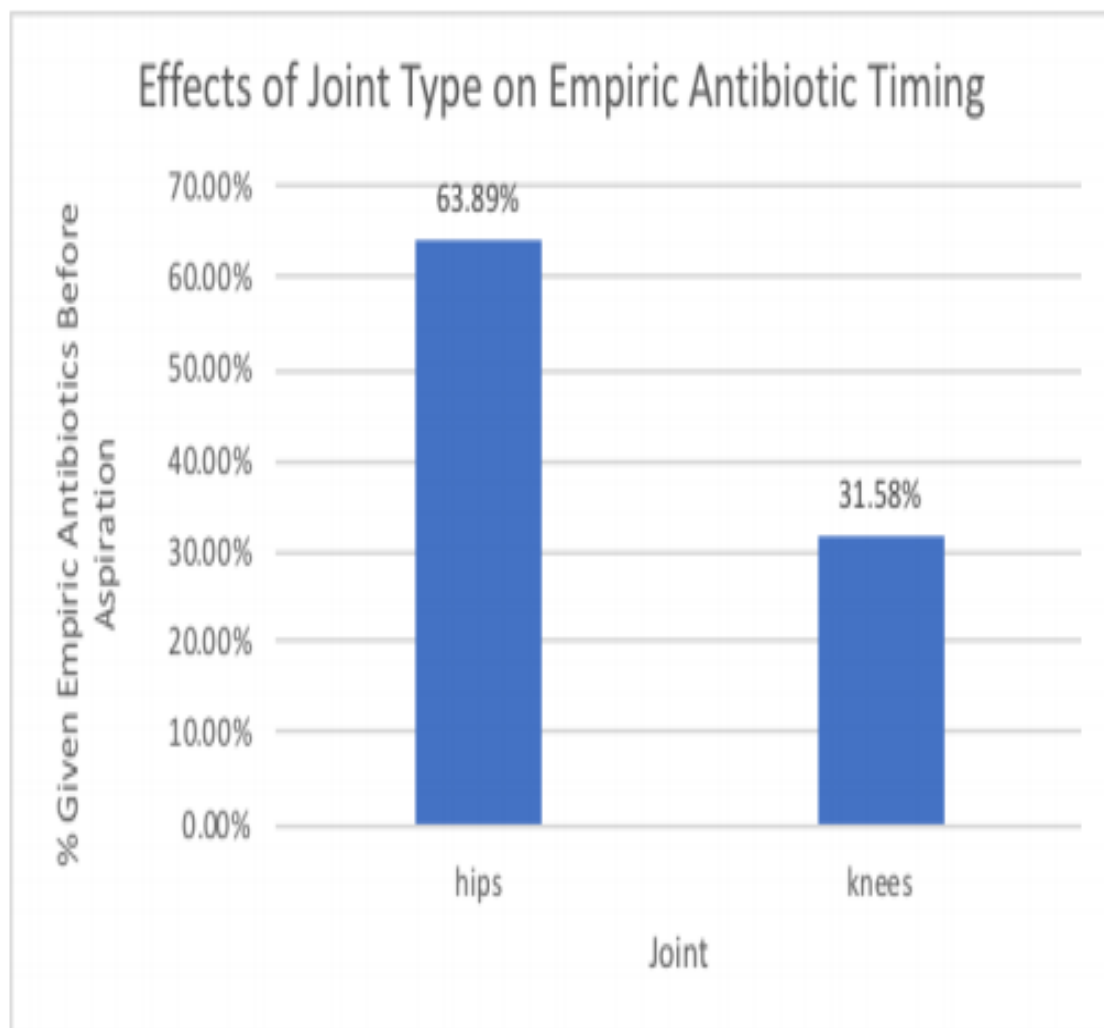
Study Question: It was hypothesized that septic hips would take a greater time to aspirate, culture, and administer targeted antibiotics than infected knees.

Methods: An IRB approved review of medical records was used to track the time taken to aspirate and then give culture-directed antibiotics for infected knees and hips. Inclusion criteria included suspected septic arthritis in the hip or knee in addition to synovial fluid aspiration.

Results: We reviewed 36 hips and 76 knees all having an eventual diagnosis of septic arthritis. 63.9% (23/36) hips and 31.6% (24/76) knees received empiric antibiotics prior to diagnostic aspiration. Joints which were aspirated prior to antibiotic administration were 28% more likely to yield positive cultures and allow antibiotic susceptibility testing. Additionally, hips saw wait times to aspiration of 31.9 hours longer, with an additional delay of 55 hours until culture-directed antibiotics could be given.

Discussion: The results show a wide gap in the time it takes to establish culture directed treatment in cases of septic arthritis between hips and knees. One potential explanation for this is the need for image guidance to obtain cultures in hips. Research has shown that increasing the time to targeted antibiotics also increases the risk of negative outcomes including limb loss, and death. Addressing the delay to aspiration may provide one route to improving these outcomes.

Conclusion: We found a significant difference in time to aspiration and targeted antibiotic administration in the treatment of hips vs. knees with hips more likely to receive empiric antibiotics prior to aspiration. The requirement for image guided aspiration in hips offers one avenue to address these differences. Altering protocols to decrease time to aspiration and perform more aspirations before antibiotic administration may improve clinical outcomes.



Outcomes of Knee Endofusion for Prosthetic Joint Infection

Alexandra Stavrakis, Sai Devana, Madhav Chowdhry, Edward McPherson, Matthew Dipane

Background / Rationale: Prostalac endofusion (FUS) can be used as a construct for stage one of a prosthetic joint infection (PJI) or as a definitive salvage option in patients with recurrent PJI in TKA. We present a retrospective review of 81 patients who underwent FUS for chronic PJI.

Study Question: 1) What are the outcomes and complications following FUS for PJI?
2) Are specific organisms or McPherson host staging associated with infection associated failure?

Methods: From October 2009 to September 2019, 81 patients underwent FUS at a single institution using a modular arthrodesis system. Mean follow-up was 52 months. Knee society scores (KSS) were recorded prior to FUS and at most recent follow-up. Logistic regression was used to evaluate the association between organism and McPherson host type with FUS failure secondary to infection.

Results: Mean age was 67 years. The majority of patients were B hosts (56%) with a 3 limb score (54%). Mean time from prior surgery to FUS was 25 months. 46% of patients had a prior explantation (60% with a prior failed 2-stage exchange). Staphylococcus epidermidis was the most common infecting organism (22.2%), followed by Staphylococcus aureus (18.5%). There was an 8.6% in-house complication rate and 29.6% overall complication rate, excluding reinfection. 29% had at least one reoperation, excluding second-stage reimplantation. 10% underwent a repeat FUS and 7% underwent amputation. 68% went on to endoprosthesis conversion. For patients who were not reimplanted, there was a 42.3% endofusion survival. There was no statistically significant association between endofusion failure and index infecting organism or McPherson host type. Clinical KSS decreased following FUS (31 ± 5.7 to 23 ± 3.6 , $p < 0.05$). There was no significant difference in functional KSS before and after FUS (15 ± 4.3 to 14 ± 4.3 $p > 0.05$).

Discussion: Although FUS is associated with a fair number of complications and repeat surgeries, the majority of patients undergo successful endoprosthetic reconstruction. Decreased clinical KSS is attributable to null range of motion with FUS.

Conclusion: FUS is a good surgical option for patients with chronic PJI of the knee, in particular for patients with recurrent infections. There was no significant association between infecting organism or McPherson host type and FUS failure secondary to infection.

Patient Outcomes

In-house complications (%)	8.6
Overall complications (% , excluding reinfection)	29.6
Medical	9.9
Surgical	19.8
Persistent infection / re-infection (%)	17.3
Reoperation (% , excl. endoprosthesis conversion)	29.6
Amputation	7.4
Fracture fixation	7.4
Repeat 2-stage	9.9
Irrigation and Debridement	14.8
Conversion to endoprosthesis (%)	67.9
Re-infection of endoprosthesis following conversion	32.1
Survivorship of endofusion w/o conversion	42.3

ID: 87

Outcomes of Patients Undergoing Second Stage Reimplantation following Knee Endofusion for PJI

Alexandra Stavarakis, Sai Devana, Madhav Chowdhry, Edward McPherson, Matthew Dipane

Background / Rationale: Knee fusion (FUS) is a salvage treatment option for recurrent prosthetic joint infection (PJI) or can be used for PJI associated with significant bone loss. Reimplantation endoprosthetic reconstruction (REI) is an option in FUS patients who are not satisfied with the physical function of FUS and have evidence of PJI clearance. We present a retrospective review of a 56 patient cohort who underwent conversion of FUS to REI.

Study Question: 1) What is the survivorship of patients undergoing conversion of FUS to REI? 2) Is there an association between patient factors (i.e., infecting organism, McPherson host grade) and REI failure?

Methods: From January 2010 to December 2019, 56 patients underwent conversion of FUS to REI at a single institution. All patients were staged according to the McPherson Staging System. Infecting organism was documented based on pre-FUS aspiration. Knee Society Scores (KSS) were recorded pre-REI and at latest follow-up. SAS was used to calculate rate ratios (RR) for relevant patient factors. RR were calculated using Poisson regression with a log link.

Results: Mean patient age was 67. The majority were B hosts (62.5%) with a type 2 (46.4%) or type 3 (51.8%) limb score. The most common infecting organisms were Staph epi (23.2%) and Staph aureus (23.2%, MSSA 14.3% vs MRSA 8.9%). Mean time to REI was 220 days. There was an 8.9% in-house complication rate and 21.4% overall complication rate (excluding infection). 67% remain infection-free at 37 month (5-117) mean follow-up (96.4% survivorship). Clinical KSS improved by mean of 24 points ($p < 0.05$) and functional KSS by mean of 22 points ($p < 0.05$). 53.6% had a deficient extensor mechanism, 16.7% of which underwent delayed extensor mechanism reconstruction (60% allograft survival). There was no statistically significant association between index organism or McPherson host type and REI failure secondary to infection.

Discussion: REI is a good option for patients with FUS who remain infection-free and are unsatisfied with their functional outcome. Clinical and functional KSS improved significantly from pre-REI scores.

Conclusion: Approximately two thirds of patients who undergo conversion from FUS to REI have infection free survival at mid-term follow-up. Index infecting organism and McPherson host type does not appear to be significantly associated with re-infection risk.

Patient Outcomes

In-house complications (%)	8.9
Overall complications (% , excluding reinfection)	21.4
Medical	7.1
Surgical	14.3
Reoperation (%)	41.1
Explant/conversion to fusion	16.1
Amputation	12.5
Periprosthetic fracture	3.6
Irrigation and Debridement	8.9
Chronic antibiotic suppression (%)	5.4
Infection-free survival (%)	66.1
Survivorship of endoprosthesis (excluding reinfection) (%)	96.4
Extensor mechanism status	
Intact (%)	46.4
Knee range of motion at latest f/u (degrees)	95 ± 25 (12 – 124)
Deficient (%)	53.6
Delayed extensor mechanism allograft	5 (16.7%)
Extensor mechanism allograft survival*	3 (60%)

*Extensor mechanism allograft failures: 1 reinfection, 1 tendon disruption at mean of 135 days

Compressive Osseointegration Device for Management of Previously Infected, Non-Oncologic Salvage Arthroplasty

Scott Galey, James Chen, Shannon Wu, Mahdavi Chowdhry, Matthew Dipane, Nicholas Bernthal, Adam Sassoon, Edward McPherson

Background / Rationale: Non-oncologic salvage arthroplasty is a growing field due to the increasing number of multiply-revised patients. Bone preservation is paramount, especially in the setting of periprosthetic joint infection (PJI). Compressive osseointegration is a method employed to avoid intramedullary fixation in a bone deficient femur. We present a consecutive series over 15 years utilizing a compressive osseointegration device for complex hip and knee arthroplasty in previously infected joints.

Study Question: Are compressive osseointegration devices a viable salvage alternative in the second-stage reimplantation of an infected THA or TKA?

Methods: From June 2004 - March 2020, 44 consecutive revision TKAs & THAs using the Compress® (CPS) device method were performed. All CPS devices were placed as a second-stage reimplantation once infectious workup was negative. This cohort was reviewed retrospectively for implant failure, complications, and outcome scores (Knee Society & Harris Hip). Kaplan-Meier survival analysis was performed.

Results: 31 revision TKAs in 26 patients and 13 revision THAs in 11 patients with a previously diagnosed PJI were reviewed. There were 20 females & 17 males. Mean age was 63.1 years (26-86). Survivorship at final follow up was 40%. 27 (60%) implants failed: 11 (25%) periprosthetic fracture, 9 (20.5%) recurrent infection, and 7 (15.9%) mechanical loosening. Average time to failure was 1.0 year. Mean time to follow-up/failure was 1.8 years (0.5 to 9.5 years). On average, studied limbs underwent 5.6 procedures pre-CPS. Amongst surviving implants, mean KSS improved 29 points (17-55) from 33 (25-55) to 62 (45-82). Mean HHS improved 27 points (14-53) from 38 (20-52) to 65 (52-75).

Discussion: The compressive osseointegration method demonstrated a survivorship of 40% at a mean follow up of 3 years for surviving implants. At early follow-up, CPS implants demonstrated a high failure rate, with fracture representing a plurality. While a minority, surviving implants showed promising improvements in clinical outcome scores.

Conclusion: CPS devices offer an alternative when femoral bone stock is unsupportive of long stems, but pose a high risk for early failure, particularly fracture.

ID: 99

A dry aspiration prior to reimplantation arthroplasty should not be considered reassuring

Joseph Karam, Steven Yacovelli, Matthew Grosso, Javad Parvizi

Background / Rationale: Dry joint aspiration prior to reimplantation, in patients with a cement spacer in place, is common in patients undergoing 2-stage exchange arthroplasty for prosthetic joint infection (PJI). A dry aspiration can be problematic on many accounts including the inability to rule out persistence of infection.

Study Question: What are the risk factors for dry aspiration prior to reimplantation? Does dry aspiration predict a favorable outcome of PJI treatment?

Methods: We performed a retrospective analysis of 177 consecutive patients undergoing reimplantation at a single institution. PJI was diagnosed per the 2018 ICM criteria. We excluded patients with no aspiration prior to reimplantation and those with less than 2 years of follow-up. Treatment failure was defined according to the Delphi

Results: One hundred four patients had knee PJI and 73 had hip PJI. Mean age was 64.6 years. Sixty-four patients (36.2%) presented a dry aspiration prior to reimplantation. Obtaining a dry aspiration was not significantly related to age, gender, BMI, joint, PJI chronicity, comorbidities, organism, antibiotic, or time from resection arthroplasty. Dry aspiration was significantly more common in patients with PJI after revision surgery and those having negative-culture PJI ($p=0.027$ and $p=0.020$). Twenty-three patients (13.0%) failed treatment within 2 years. Patients with a dry tap did not significantly differ in outcomes of mortality, intraoperative culture positivity at reimplantation, or failure of treatment.

Discussion: Joint aspiration is often performed to guide reimplantation in PJI treatment. Dry aspiration was seen in about one third of patients in accordance with prior literature. Patients who present PJI after revision arthroplasty and those who have culture-negative PJI seem to be at higher risk of dry aspirations. Other factors such as patient demographics, comorbidities, infectious organism or antibiotic treatment do not seem to affect the success of aspiration. Patients with a dry aspiration had similar failure rates and mortality to those with a successful aspiration.

Conclusion: We caution against the erroneous reassurance of surgeons and patients when obtaining dry aspirations prior to reimplantation in the treatment of PJI of the hip and knee.

Risk Factors Associated With Developing Surgical Site Infections or Peri-Prosthetic Joint Infections Following Primary Total Hip Arthroplasty for Acetabular Fractures

Rushabh Vakharia, Matthew Ciminero, Angelo Mannino, Asad Ashraf, Michael Mont, Kevin Kang

Background / Rationale: While studies have shown favorable outcomes in utilizing primary total hip arthroplasty (THA) for the treatment of acetabular fractures, infections can lead to poor outcomes and increase healthcare expenditure.

Study Question: Therefore, the purpose of this study was to: 1) compare patient demographics of patients who did and did not develop infections; and 2) identify patient-related risk factors associated with the development of infections following primary THA for acetabular fractures.

Methods: Patients who developed surgical site infections (SSIs) within 90-days or peri-prosthetic joint infections (PJIs) within 1-year following the procedure were identified within an administrative claims database and served as the study cohort; whereas patients not developing infections served as controls. The query yielded 997 patients who developed SSIs (n = 429) or PJIs (n = 568) out of 12,071 patients. Outcomes analyzed included comparing patient demographics such as age, sex, and comorbidity burden measured by the Elixhauser-Comorbidity Index (ECI). Multivariate binomial logistic regression analyses was used to calculate the risk of developing SSIs or PJIs following primary THA for acetabular fractures. A p-value less than 0.001 was considered statistically significant.

Results: Study group patients were generally older, male, and had significantly higher comorbidity burden for those who developed SSIs (9 vs 7, $p < 0.0001$) or PJIs (11 vs. 9, $p < 0.0001$). The study found the greatest odds (OR) for SSI were obesity (OR: 1.85, $p < 0.0001$), pathologic weight loss (OR: 1.63, $p < 0.0001$) and depression (OR: 1.45, $p < 0.0001$); whereas, the greatest risk factors for PJIs were iron deficiency anemia (OR: 2.01, $p < 0.0001$), pathologic weight loss (OR: 1.73, $p < 0.0001$), and morbid obesity (OR: 1.71, $p < 0.0001$).

Discussion: Utilization of THA for these injuries continues to increase due to its favorable outcomes compared to other surgical interventions. This study found the greatest risk factors for SSIs were obesity, pathologic weight loss, and depression; whereas, the greatest risk factors for PJIs were iron deficiency anemia, pathologic weight loss, and morbid obesity.

Conclusion: The study is vital as it can allow orthopaedic surgeons to identify these high-risk patients and adequately optimize them prior to surgery to potentially mitigate these adverse events from occurring.

<i>Surgical Site Infections</i>			
Variables	Odds-Ratio	95% Confidence Interval	p-value
Gender			
Male	1.06	0.85 – 1.32	0.597
Comorbidities			
Alcohol Use Disorder	1.0	0.71 – 1.38	0.973
Arrhythmias	1.01	0.81 – 1.26	0.905
Blood Loss Anemia	1.41	1.10 – 1.80	0.005
BMI <19kg/m ²	0.64	0.34 – 1.09	0.131
BMI 19 – 24kg/m ²	0.99	0.56 – 1.63	0.997
BMI 25 – 29kg/m ²	0.98	0.60 – 1.51	0.945
BMI 30 – 39kg/m²	1.84	1.38 – 2.42	<0.0001
BMI 40 – 70kg/m ²	1.43	0.98 – 2.04	0.051
Congestive Heart Failure	1.08	0.85 – 1.36	0.509
Coagulopathies	1.10	0.87 – 1.37	0.387
COPD	1.17	0.77 – 1.71	0.438
Depression	1.48	1.19 – 1.85	0.0003
Diabetes Mellitus	1.05	0.85 – 1.31	0.602
Electrolyte/Fluid Imbalance	1.20	0.91 – 1.60	0.190
Hypertension	1.31	0.87 – 2.07	0.212
Hyperlipidemia	0.99	0.78 – 1.27	0.987
Hypothyroidism	1.06	0.86 – 1.31	0.534
Iron Deficiency Anemia	1.59	1.20 – 2.14	0.001
Liver Failure	0.94	0.68 – 1.29	0.740
Lymphoma	1.10	0.66 – 1.74	0.675
Metastatic Cancer	0.95	0.65 – 1.34	0.806
Paralysis	0.77	0.50 – 1.14	0.222
Peptic Ulcer Disease	0.98	0.73 – 1.29	0.890
Peripheral Vascular Disease	1.11	0.90 – 1.38	0.311
Renal Failure	1.12	0.82 – 1.50	0.454
Rheumatoid Arthritis	0.95	0.74 – 1.21	0.692
Tobacco Use	1.03	0.79 – 1.32	0.817
Valvular Issues	0.97	0.77 – 1.22	0.861
Weight Loss	1.64	1.31 – 2.06	<0.0001
<i>Peri-Prosthetic Joint Infections</i>			
Variables			
Gender			
Male	0.89	0.73 – 1.08	0.254
Comorbidities			
Alcohol Use Disorder	1.11	0.84 – 1.47	0.431
Arrhythmias	1.06	0.88 – 1.29	0.507
Blood Loss Anemia	1.34	1.07 – 1.66	0.008
BMI <19kg/m ²	0.66	0.40 – 1.07	0.097
BMI 19 – 24kg/m ²	1.03	0.66 – 1.59	0.892

BMI 25 – 29kg/m ²	1.48	1.04 – 2.10	0.026
BMI 30 – 39kg/m ²	1.46	1.13 – 1.89	0.003
BMI 40 – 70kg/m²	1.70	1.24 – 2.34	0.0001
Congestive Heart Failure	1.02	0.83 – 1.25	0.807
Coagulopathies	1.08	0.89 – 1.31	0.421
COPD	1.13	0.79 – 1.61	0.488
Depression	1.17	0.97 – 1.41	0.097
Diabetes Mellitus	1.23	1.02 – 1.48	0.029
Electrolyte/Fluid Imbalance	1.48	1.14 – 1.91	0.002
Hypertension	1.32	0.90 – 1.93	0.144
Hyperlipidemia	0.90	0.73 – 1.11	0.336
Hypothyroidism	0.90	0.75 – 1.08	0.291
Iron Deficiency Anemia	1.97	1.51 – 2.58	<0.0001
Liver Failure	1.13	0.87 – 1.48	0.346
Lymphoma	1.09	0.71 – 1.67	0.677
Metastatic Cancer	1.03	0.76 – 1.39	0.825
Paralysis	0.97	0.70 – 1.35	0.996
Peptic Ulcer Disease	0.82	0.63 – 1.06	0.899
Peripheral Vascular Disease	0.92	0.76 – 1.11	0.137
Renal Failure	1.04	0.80 – 1.36	0.393
Rheumatoid Arthritis	1.27	1.04 – 1.56	0.725
Tobacco Use	1.24	1.00 – 1.54	0.017
Valvular Issues	1.05	0.86 – 1.28	0.439
Weight Loss	1.72	1.41 – 2.08	<0.0001

Table 1. Risk-Factors Associated With Developing Surgical Site Infections Within 90-Days or Peri-Prosthetic Joint Infections Within 1-Year Following Primary Total Hip Arthroplasty for Acetabular Fractures. BMI = Body Mass Index; COPD = Chronic Obstructive Pulmonary Disease

Bolded Values Signify Statistical Significance

Transverse Posterior Wall Acetabular Fractures Undergoing Conversion Total Hip Arthroplasty are at High-Risk of Periprosthetic Joint Infection

Kyle Cichos, Clay Spitler, Gerald McGwin Jr, Elie Ghanem

Background / Rationale: Conversion THA from prior acetabular fracture ORIF have high rates of PJI compared to primary THA for OA. We hypothesized that certain acetabular fractures especially those of high energy patterns including transverse posterior wall (TPW) types are responsible for this increased risk of PJI.

Study Question: Are TPW fractures at higher risk of PJI after conversion THA than other acetabular fracture patterns?

Methods: We reviewed 1,938 acetabular fractures treated with ORIF at our institution from 2005-2019 of which 170 underwent conversion THA and met our inclusion criteria (80 TPW fractures). Conversion THA outcomes and confounding variables including those at time of ORIF were compared between the TPW fractures and all other fracture patterns. Multivariable analysis was performed including all variables with $p < 0.10$ by univariate analysis to identify independent risk factors for PJI at both 90-days and 1-year.

Results: There was no difference between the cohorts in demographics, comorbidities, and surgical variables related to the ORIF index procedure including postoperative complications and reoperations. There was also no difference between the groups among surgical variables, transfusion rates, LOS, ICU stay, discharge disposition, and HACs at time of conversion. There was no difference between the cohorts in 90-day or 1-year mechanical complications after the conversion procedure. TPW fractures had higher rates of 90-day (13.8% vs 4.4%, $p=0.055$) and 1-year (16.3% vs 5.6%, $p=0.027$) PJI. Multivariable analysis revealed that TPW fracture pattern independently predisposed to 5 times increased risk of 90-day PJI ($p=0.03$) and a 6.5 times increased risk of 1-year PJI ($p=0.01$).

Discussion: Our study revealed that TPW fractures undergoing conversion THA are at an increased risk for PJI. Although we considered numerous confounding variables at time of ORIF and conversion, soft tissue damage at time of fracture is difficult to objectively quantify. We postulate that soft tissue damage may play a major role in the increased PJI risk for these high-energy fracture patterns.

Conclusion: Transverse posterior wall acetabular fractures converted from prior ORIF to THA are at high risk of 90-day and 1-year PJI.

POSTERS

ID: 13

False Negative Alpha-Defensin: A Case Control Study

Jesus Villa, Preston Grieco, Tejbir Pannu, Aldo Riesgo, Alison KLiKa

Background / Rationale: Alpha-defensin is a valuable tool to diagnose periprosthetic joint infection (PJI). Infrequently, however, false-negative results have been reported.

Study Question: Therefore, the objective of this study is to identify characteristics associated with negative alpha-defensin results in the presence of an established PJI diagnosis.

Methods: Single-institution case-control study from November 2017 to February 2020. Eight cases (hips=6/knees=2) with established diagnosis of PJI according to 2013 Musculoskeletal-Infection-Society (MSIS) diagnostic criteria (7/8 diagnosed with major criteria, all with known organism) reported negative alpha-defensin (false-negatives/cases). Cases were matched by age, gender to cases (1:1 ratio) with established diagnosis of infection, known causative organism, and positive alpha-defensin (true-positives/controls). Demographics, surgical characteristics, and MSIS-criteria values were compared between both groups. Synovial fluid was obtained in all cases without joint lavage. Alpha was set at 0.05.

Results: There were no significant differences on demographics, BMI, smoking/immunosuppression status, joint/procedure type, average number of surgeries performed in the joint prior to alpha-defensin collection, or on whether the joint aspiration was performed while the patient was receiving antibiotics. In the false-negative group, there were only 2 cases with sinus tract (no significant differences in this regard when compared to the control group). C-reactive protein and erythrocyte sedimentation rate were not significantly different either. However, the synovial white-blood-cell (WBC) count and the polymorphonuclear percentage (PMN%) were significantly lower in the false negative group when compared to the control group (1,936-cells vs. 47,941-cells, 67.28% vs. 95.36%, respectively). Overall, the most frequent infecting organisms belonged to the staphylococcus genus.

Discussion: False negative alpha-defensin is significantly associated with a low synovial WBC count and PMN%.

Conclusion: A negative alpha-defensin result with concomitant low WBC and PMN% according to MSIS-criteria should be regarded highly suspicious of a false-negative report when additional evidence suggests the presence of PJI.

International Organism Profile of Periprosthetic Total Hip and Knee Infections

Jesus Villa, Tejbir Pannu, Nemandra Sandiford, Daniel Kendoff, Alison Klika

Background / Rationale: It is unclear if the prevalence of resistance organisms causing (PJI) in total hip/knee arthroplasty is different among North/South American and European countries.

Study Question: Therefore, we sought to compare causative organisms, rates of resistant organisms, and polymicrobial infections in hospitals in North/South America, and Europe.

Methods: Retrospective study of 654 PJIs (hips=361/knees=293) identified at two facilities in the United States (US) (n=159) and single institutions in Argentina (n=99), Uruguay (n=130), United Kingdom (UK) (n=103), Germany (n=59), and Russia (n=104) (January 2006-October 2019). Alpha was set at 0.05.

Results: Overall, the most frequent organisms identified were *Staphylococcus aureus* (24.8%) and *epidermidis* (21.7%). The incidence of organisms resistant to at least one antibiotic was 58% with a significant difference between hips (62.3%) and knees (52.6%) ($p=0.014$). Rates of resistant organisms among countries were significantly different: 37.7%-US, 66.7%-Argentina, 71.5%-Uruguay, 40.8%-UK, 62.7%-Germany, 77.9%-Russia ($p<0.001$). The overall incidence of polymicrobial infections was 9.3% and the rates across nations were significantly different: 9.4%-US, 11.1%-Argentina, 4.6%-Uruguay, 4.9%-UK, 11.9%-Germany, 16.3%-Russia ($p=0.026$). On the hips, the incidence of resistant organisms was 62.3% while polymicrobial infections accounted for 10.5% of all cultures. The rates of resistant organisms in each country were: 42.9%-US, 59.2%-Argentina, 78.5%-Uruguay, 41.3%-UK, 63.9%-Germany, 80.0%-Russia ($p<0.001$). Incidences of polymicrobial infections were: 9.1%-US, 6.1%-Argentina, 6.5%-Uruguay, 6.5%-UK, 16.7%-Germany, 21.7%-Russia ($p=0.024$). Regarding the knees, the incidences of resistant organisms and polymicrobial infections were 52.6% and 7.8%, respectively. Rates of resistant organisms in each country: 32.9%-US, 74%-Argentina, 54.1%-Uruguay, 40.4%-UK, 60.9%-Germany, 75%-Russia ($p<0.001$). Frequencies of polymicrobial infections: 9.8%-US, 16%-Argentina, 0%-Uruguay, 3.5%-UK, 4.3%-Germany, 9.1%-Russia ($p=0.072$).

Discussion: *Staphylococcus aureus* and *epidermidis* accounted for almost 50% of all infections. The US and the UK had the lowest incidence of resistant organisms while Germany and Russia had the highest. The UK and Uruguay had the lowest rates of polymicrobial infections.

Conclusion: These differences between countries and continents may affect comparative studies that evaluate treatments for PJI.

ID: 16**Platelet deficiency represents a reversible risk factor for periprosthetic joint infection in a pre-clinical mouse model.**

Danielle Greig, Rishi Trikha, Troy Sekimura, Nicolas Cevallos, Benjamin Kelley, Zeinab Mamouei, Michael Yeaman, Nicholas Bernthal

Background / Rationale: Well-known for their role in coagulation, platelets are increasingly being recognized for their important role in the host defense against microbial pathogens, thus representing a modifiable potential risk factor for periprosthetic joint infection (PJI). The purpose of this study was to utilize an established mouse model to investigate the role of platelets in the host response to PJI.

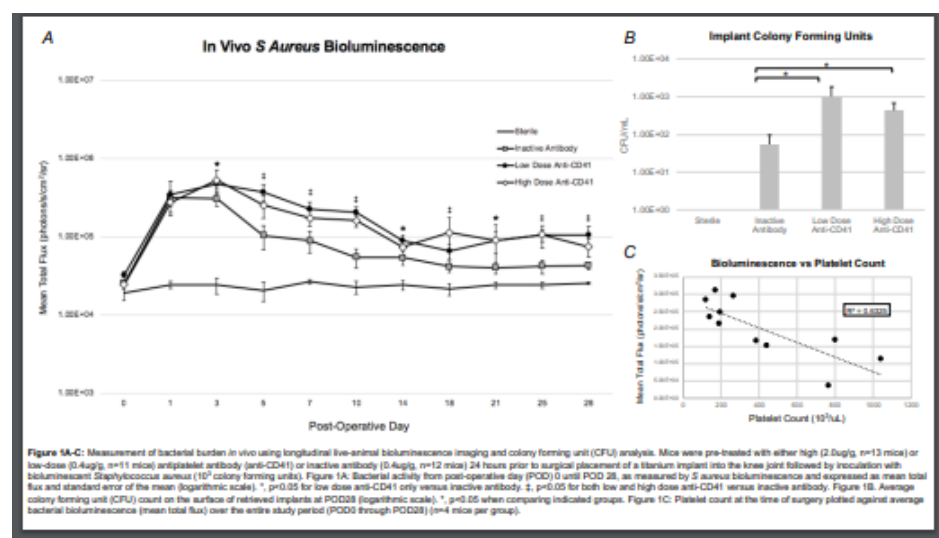
Study Question: Does platelet depletion increase infectious burden ex vivo and, if so, is the effect reversible? In a mouse model of PJI, will platelet depletion result in an increased rate and severity of infection?

Methods: Thrombocytopenia was induced in mice utilizing a selective antibody against CD41, while control mice were treated with an inactive antibody. For ex vivo studies, blood from pre-treated mice was incubated with bioluminescent Xen36 *Staphylococcus aureus*. Platelets harvested from an untreated mouse were added as a rescue arm. Bacterial burden was assessed using bioluminescent imaging, crystal violet assay, and colony forming unit (CFU) analysis. For in vivo studies, pre-treated mice underwent surgical placement of a titanium implant in the knee joint, which was inoculated with bioluminescent *S aureus*. Longitudinal live-animal bioluminescence imaging was performed postoperatively to quantify bacterial burden, which was confirmed via CFU analysis of implant surface bacteria and peri-implant tissue at postoperative day (POD) 28.

Results: Platelet counts were significantly reduced in mice treated with anti-CD41. Ex vivo studies demonstrated significantly higher bioluminescence and bacterial biomass in thrombocytopenic blood. These findings were reversed with the addition of platelets. In vivo, bacterial bioluminescence was significantly higher in thrombocytopenic mice at all time points after POD3 and was inversely correlated with platelet count. CFU analysis at POD28 demonstrated a significantly increased rate and severity of implant infection in thrombocytopenic mice.

Discussion: Thrombocytopenia is associated with an increased infectious burden both ex vivo and in a mouse model of PJI. In the orthopaedic population, platelet deficiency represents a reversible target for the prevention of PJI.

Conclusion: Platelet depletion resulted in a reversible increased infectious burden ex vivo as well as an increased rate and severity of PJI in a pre-clinical mouse model.



ID: 20

Local use of Vancomycin in patients with documented Vancomycin allergy

Herrick Siegel, Christopher Odom, Matthew Hess, Kevin Wall

Background / Rationale: Vancomycin is commonly used in local antibiotic carriers such as cement and calcium phosphate. In patient with a positive history of MRSA, vancomycin may be highly effective. There are patients with documented reactions to vancomycin when administered intravenously.

Study Question: Do patient with documented systemic reactions to intravenous vancomycin have a similar sensitivity when vancomycin is used in local carrier?

Methods: 81 patients with documented histories of vancomycin allergy were identified between 2007-2016. All patients were undergoing treatment for staph aureus periprosthetic joint infections that were sensitive to vancomycin. Of the 81, 54 of these patient had vancomycin used locally with doses varied from 2 to 6 grams. These patients did not receive intravenous vancomycin due to documented history of vancomycin. Renal function and local reactions were evaluated. Renal function was check at 2 days post op, 2 weeks post op and 4 weeks post op as part of routine infection disease specialist protocol.

Results: Of these 54 patients, there were no local reactions identified that could be contributed to vancomycin specifically. In 7 patients, creatine and BUN were noted to be elevated; however improved by 2 weeks post op. In the 27 patients treated without vancomycin, similar local findings were seen, such as drainage. No systemic reactions were seen with the use of vancomycin locally in the spacer or beads.

Discussion: Vancomycin is a commonly used and valuable antibiotic for treatment of periprosthetic joint infections. Concerns regarding allergy in some patients have prevented its use in patients with known infections sensitive to vancomycin. In this study, no such systemic reactions were seen. In the patients treated with higher local dosages of vancomycin (over 4 grams), renal function was transiently abnormal; however this corrected within 2 weeks post operative.

Conclusion: The use of local vancomycin within cement or calcium phosphate carriers is not contraindicated for patients with documented vancomycin. Most recorded vancomycin allergies are caused for rapid intravenous administration which is not seen with slow antibiotic elusion from spacers and beads. Based on our findings, vancomycin impregnated cement and beads may be used in patients with documented systemic vancomycin allergy.

Timing of Antibiotic Initiation in the Treatment of Septic Arthritis Patients

Jared Alswang, Nathan Varady, Antonia Chen

Background / Rationale: Septic arthritis is a painful infection of articular joints that is typically treated by irrigation & debridement along with antibiotic therapy. There is no consensus whether antibiotic administration should be delayed in septic arthritis patients until fluid cultures have been taken in order to improve culture yield or initiated early in order to improve clinical outcomes. Therefore, the purpose of this study was to determine whether delayed antibiotic treatment affects culture yield and prognosis of septic hip/knee/shoulder arthritis patients.

Study Question: Does early antibiotic administration affect culture yields and clinical outcomes in septic arthritis patients?

Methods: A retrospective analysis was conducted on 111 patients with hip, knee, or shoulder septic arthritis admitted from 3/2016-11/2018. In patients with multiple septic joints, each joint was analyzed individually (n=122). Diagnosis was determined by irrigation & debridement and/or a positive culture. Demographics, laboratory tests, culture results, and intervention times were obtained. Patients were grouped based on antibiotic therapy timing: >24 hours prior to arthrocentesis (Group 1), between 24 hours to 1 hour prior (Group 2), and 1 hour prior to post-arthrocentesis (Group 3).

Results: The mean age of each group were similar: Group 1 (n=38) 55.7 years, Group 2 (n=20) 57.2 years, and Group 3 (n=64) 54.8 years. No difference was observed in positive cultures between groups (p=0.825): Group 1=71.1% (27/38), Group 2=75% (15/20), and Group 3=76.6% (49/64). Similarly, frequency of related readmissions within 90 days (p=0.863) did not significantly differ: 26.3% (10/38) in Group 1, 20% (4/20) in Group 2, and 25% (16/64) in Group 3. Additionally, there were no significant differences in culture sensitivity in the knee (p=0.618; Groups: 87.5%, 75%, 70.6%), shoulder (p=0.517; Groups: 77.8%, 66.7%, 90%), and hip (p=0.362; Groups: 61.9%, 80%, 80%).

Discussion: Fluid culture sensitivities were similar for all patients and in individual joint types regardless of antibiotic administration timing. Additionally, timing of antibiotic administration did not significantly impact the rate of readmission after 90 days.

Conclusion: These results suggest that antibiotic administration should not be delayed in septic arthritis to improve culture yields. However, results are inconclusive if early antibiotic administration will result in better clinical outcomes, and further research is needed.

ID: 35

Rheumatoid Arthritis Does Not Increase Infectious Burden in a Pre-Clinical Mouse Model of Periprosthetic Joint Infection

Rishi Trikha, Danielle Greig, Benjamin Kelley, Zeinab Mamouei, Troy Sekimura, Nicolas Cevallos, Alexandra Stavrakis, Adam Sassoon, Nicholas Bernthal

Background / Rationale: Periprosthetic joint infection (PJI) represents a devastating complication of total joint arthroplasty with limited diagnostic and treatment options. There is literature to suggest a higher incidence of PJI in patients with rheumatoid arthritis (RA), though the mechanism behind this association is not fully understood.

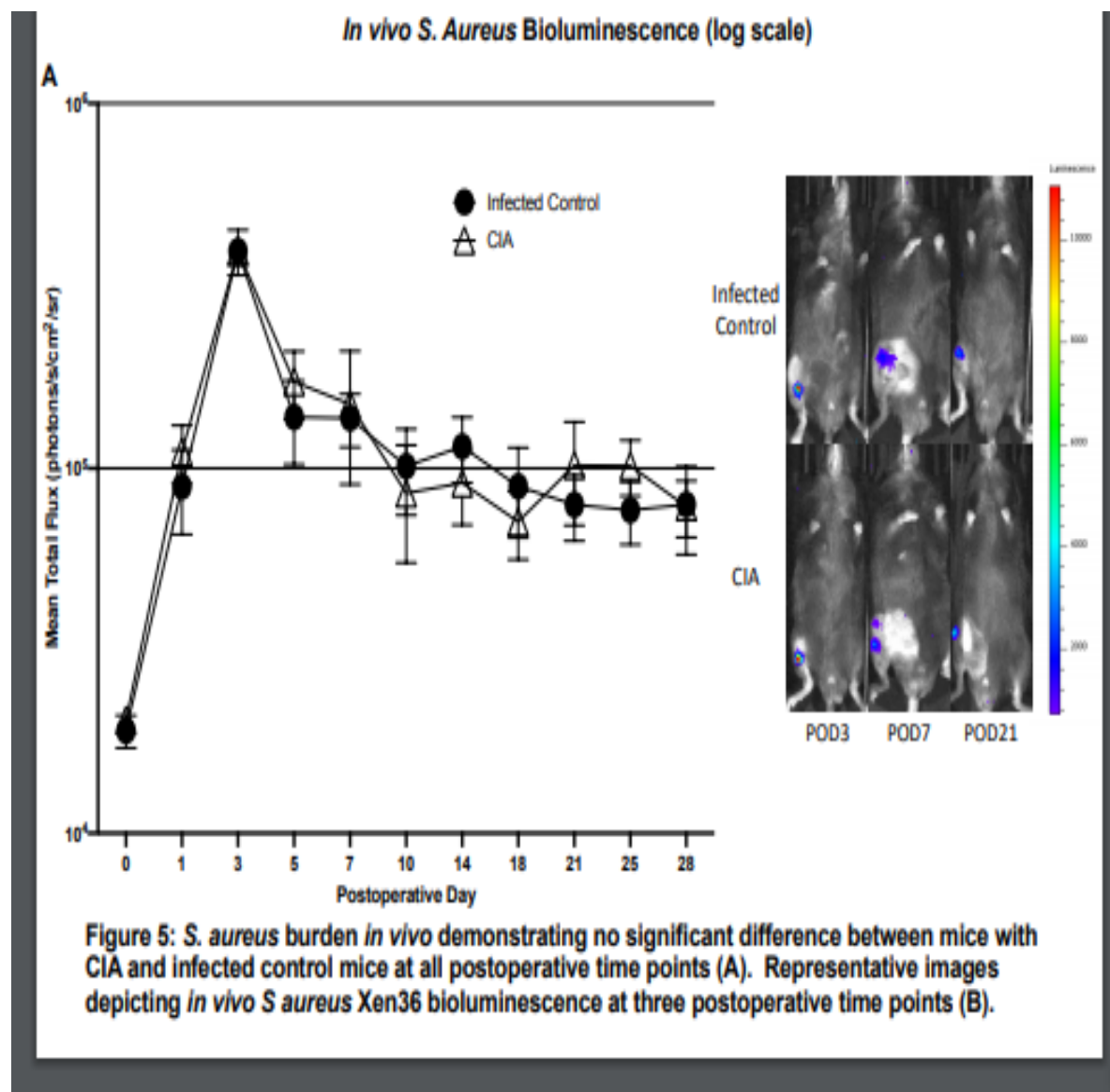
Study Question: The purpose of this study was to determine how collagen-induced arthritis (CIA), a validated animal model of RA, would impact infectious burden in a well-established model of PJI.

Methods: CIA was induced in C57BL/6J mice. Whole blood from CIA mice and control mice was collected to quantify systemic IgG levels via ELISA and respiratory burst function via dihydrorhodamine assay. Ex vivo *Staphylococcus aureus* Xen36 burden was measured via colony forming unit (CFU) counts and a crystal violet assay measuring biofilm formation. For in vivo experiments, surgical placement of a titanium implant in the knee joint and inoculation with *S. aureus* Xen36 was performed. Quantitation of infectious burden in vivo occurred via longitudinal bioluminescence imaging. In vivo CFU counts of *S. aureus* adherent to the implant as well as in the surrounding tissue were measured to further assess infectious burden between groups.

Results: Mice with CIA demonstrated significantly higher levels of systemic IgG compared with control mice ($p < 0.01$). Ex vivo, there was no significant difference in respiratory burst function ($p=0.89$) or *S. aureus* bacterial burden as measured by CFU counts ($p=0.91$) and crystal violet assay ($p=0.96$). In vivo, no significant difference in bacterial bioluminescence between groups was found at all postoperative time points. CFU counts of both the implant and the peri-implant tissue were not significantly different between groups ($p=0.82$ and 0.80 , respectively).

Discussion: These results suggest that RA alone, without therapeutics, may not represent a significant risk factor for PJI. Further mechanistic translational and clinical studies are, however, warranted to thoroughly investigate the infectious risk of RA.

Conclusion: This study demonstrated no difference in *S. aureus* infectious burden between mice with CIA, a validated model of RA, and healthy control mice.



Surgical Helmets Increase Bioburden in the Operative Room

Emanuele Chisari, Chad Krueger, Scot Brown, Javad Parvizi

Background / Rationale: Surgical helmet/hood systems, such as those commonly used during joint arthroplasty procedures, are not sterilized and not routinely cleaned between cases. The positive pressure generated by their airflow systems may be able to distribute particles throughout an operating room.

Study Question: This study hypothesized that commonly worn surgical helmets can be carriers of bacteria and can ultimately increase the bioburden of a operating room.

Methods: A prospective pilot study was designed. The primary endpoint was bacteria found on the helmets themselves and the foreheads of the personnel who would wear the helmets. Secondary endpoints were whether sampling the surgeon skin before or after surgeries makes any difference, as well as pathogen features. The sampling technique consisted of the use of sterile DNase and RNase free swabs. One swab was used on the forehead of the surgeon as control. Another swab was used in the helmet pads and plastic airflow tube. All samples underwent next generation sequencing (16S RNS sequencing) for bacteria identification. Results were limited to bacteria found in orthopaedic infections.

Results: We randomly collected 13 helmet samples and 8 forehead skin control samples from 12 different surgical staff either at the beginning of the surgical day, in between cases or at the end of the day. Helmets were positive for bacteria in 11/13 (84%) of cases. The most common species found was *Cutibacterium acnes* (91%) and polymicrobial findings were discovered in 6 cases (54%). A wide variety of *Staphylococci* (%) and *Streptococci* (%) were found. The forehead swabs were positive in 5 of the 9 samples (55%) with the most common bacteria being *Cutibacterium acnes* (60%) but 4 of the 5 positive samples being polymicrobial. When we compared the forehead swabs collected at the beginning of the day (4) versus the ones collected in between cases or at the end of the surgical day (4), only 1 sample was positive in the morning while all 4 late samples were positive. No multi-resistant organisms were reported.

Discussion: Based on the findings of this study, it appears surgical helmets are a vector of bioburden inside and outside of the surgical area. Further studies should aim to confirm these findings in other institutions.

Conclusion: We recommend caution in the use of helmets and other instruments that cannot be properly cleaned at the end of the procedures as they could be a source of bacterial contamination during use.

Diagnostic Utility of a Novel Point-of-Care Test of Calprotectin for Periprosthetic Joint Infection after Total Knee Arthroplasty: An Exclusion Test?

Alison Klika, Jared Warren, Hiba Anis, Kathy Bowers, Tejbir Pannu, Jesus Villa, Jessica Colon-Franco, Nicolas Piuze

Background / Rationale: Despite several synovial fluid biomarkers for diagnosis of periprosthetic joint infection (PJI) have been investigated, point-of-care (POC) tests using these biomarkers are not widely available. Synovial calprotectin has recently been reported to effectively exclude diagnosis of PJI.

Study Question: Is the calprotectin POC valid compared to the enzyme linked immunosorbent assay (ELISA) at 2 separate thresholds for PJI diagnosis in total knee arthroplasty (TKA) patients using the 2013 Musculoskeletal Infection Society (MSIS) PJI diagnosis criteria as the gold standard.

Methods: Intraoperative synovial fluid samples were prospectively collected from 123 patients who underwent revision TKAs (rTKA) at two academic hospitals within the same healthcare system from October 2018 to January 2020. The study was conducted under IRB approval. Included patients followed the hospital standard for their PJI diagnostic work-up. Patients were categorized as septic or aseptic using MSIS criteria by two independent reviewers blinded to calprotectin assay results. The calprotectin POC and ELISA test performance characteristics were calculated with sensitivities, specificities, positive, and negative predicted values (PPV and NPV, respectively) and areas under the curve (AUC) for 2 different PJI diagnosis scenarios: (1) a threshold of ≥ 50 mg/L and (2) a threshold of ≥ 14 mg/L.

Results: According to MSIS criteria, 53 rTKAs were septic while 70 rTKA were aseptic. In the (1) ≥ 50 mg/mL threshold scenario, the calprotectin POC and ELISA performance showed 100% agreement with sensitivity, specificity, PPV, NPV, and AUC, respectively, of 98.1%, 95.7%, 94.5%, 98.5%, and 0.969. In the (2) ≥ 14 mg/mL threshold scenario, the POC slightly outperformed the ELISA with sensitivity, specificity, PPV, NPV and AUC of 98.1%, 87.1%, 85.2%, 98.4%, and 0.926, respectively (ELISA values were 98.1%, 82.9%, 81.3%, 98.3%, and 0.905, respectively).

Discussion: This test could be effectively implemented as a rule out test. However, further investigations with larger cohorts are necessary to validate these results.

Conclusion: The calprotectin POC test performed as well as the ELISA at the ≥ 50 mg/L threshold and was slightly better at the ≥ 14 mg/L threshold. The ≥ 50 mg/L threshold had a better specificity while maintaining the same sensitivity as the ≥ 14 mg/L threshold.

ID: 42

Prolonged antibiotic prophylaxis in elective orthopaedic surgery

Felix Rohrer, Anita Maurer, Hubert Noetzli, Tanja Hermann, Brigitta Gahl, Andreas Limacher, Jan Brügger

Background / Rationale: Surgical antibiotic prophylaxis (SAP) is well established to prevent surgical site infections (SSI). The pre-incisional timing of SAP is well established, but recommendations on the optimal duration are controversial. Moreover, non-adherence to common recommendations may lead to higher SSI rates or bacterial resistances. Especially in orthopaedic surgery the use of prolonged SAP (PSAP) and factors motivating to do so are insufficiently studied.

Study Question: What are the proportions of PSAP use in elective orthopaedic surgery? Are there patient- and surgery-related factors associated to PSAP use?

Methods: This cross-sectional analysis investigated 1292 patients undergoing elective orthopaedic surgery at one Swiss center between 2014 and 2017. The use of SAP administration ≥ 24 hours after surgery was defined as PSAP. Patient comorbidities, surgical characteristics and occurrence of SSI at 90 days in PSAP group were compared to the SAP group (< 24 hours postoperative). To investigate whether experienced surgeons apply different approaches, logistic regression was used. Patient characteristics and SSI occurrence was surveyed prospectively, other data was retrieved retrospectively from electronic patient charts.

Results: PSAP use was 12% (155 of 1292) with a mean duration of 2.1 (± 0.62) days. Patient-related factors associated with PSAP were older age (63 vs 58y; $p < 0.001$), higher BMI (29 vs 27kg/m²; $p < 0.001$), ASA classification ≥ 3 (31% vs 17%; $p < 0.001$) and lung disease (17% vs 9%, $p = 0.002$). Surgery-related factors associated with PSAP use were prosthetic surgery (62% vs 45%; $p < 0.001$), knee surgery (65% vs 25%; $p < 0.001$), longer surgery duration (87 vs 68min; $p < 0.001$), presence of drains (90% vs 65%; $p < 0.001$). All 4 SSI occurred in the SAP group (4 vs 0; $p = 1.0$). Crude odds ratios of surgeons to administer prolonged antibiotic prophylaxis ranged between 0.14 (95% CI 0.03 to 0.7, $p = 0.017$) and 5.0 (CI 2.0 to 12.4, $p = 0.001$).

Discussion: PSAP use was infrequent at our center and SSI proportions were low compared to literature. There were several patient and surgery-related factors associated with PSAP use, some of them being potentially modifiable. Also, experienced surgeons seem to have different approaches in regard to the duration of SAP administration.

Conclusion: Further prospective research is needed to establish solid evidence on the shortest effective SAP duration in order to standardize and ensure adherence to guidelines.

ID: 48

The impact of tranexamic acid on patients undergoing a stage 1 revision total hip arthroplasty

Herrick Siegel, Matthew Hess, Matthew Christie, Kevin Wall

Background / Rationale: Removing of hip implants in the site of a periprosthetic infection can be very morbid. As part of the stage 1 procedure, osteotomies and gauges may be used, which often can cause excessive hemorrhage. With the use of tranexamic acid, blood loss may be reduced however there remains a concern regarding the possibility of increasing the incident of thromboembolic events in patient undergoing treatment for infection.

Study Question: Does tranexamic acid reduce blood loss in patients undergoing stage 1 hip revisions and does it increase the incident of thromboembolic events?

Methods: Fifty-eight stage 2 revision THA patients were followed for 3 months post op to determine whether there was a reduction of transfusions and a change in the incident of symptomatic DVT or PTE. This was compared to a historical control of 75 patients treated from 2002-2008. Transfusion records and reports related to thromboembolic events were retrospectively reviewed on all patients.

Results: Of the 58 patients receiving TXA, 22 patients received 2 or more PRBCs in the post operative period. 12 received 1 unit of PRBCs and 24 patients did not receive a blood transfusion. There was 1 PTE and 1 DVT in this group. In the patients not receiving TXA 74 of 75 patients had at least 2 units of PRBCs and 1 patient did not have a transfusion. In this group, there was 2 PTEs and 3 DVTs noted within 3 months post op.

Discussion: Tranexamic acid was shown to possibly reduce thromboembolic events and the need for blood transfusions. The reduction of blood transfusion was statistically significantly less in the TXA group ($p=.021$). There were too few thrombotic events to show significance, but there was a trend for less.

Conclusion: Tranexamic acid is safe and effective in stage 1 revision surgery without an increase in thrombotic events. More studies are needed to determine the optimal dose timing and size.

Do we need to wait three months after corticosteroid injections to reduce the risk of infection after total knee arthroplasty?

Sarah Bhattacharjee, Sara Wallace, Hue Luu, Lewis Shi, Michael Lee, Antonia Chen

Background / Rationale: Corticosteroid injections administered within 3 months prior to total knee arthroplasty (TKA) have been linked to increased postoperative infection risk. However, no studies have further delineated injection timing specifically with corticosteroid knee injections to determine if there is a narrower window for safe administration.

Study Question: 1) Is there a different time frame between corticosteroid injection and primary TKA that increases infection risk? and 2) What are the risk factors associated with post-operative TKA infection?

Methods: TKA patients were identified from a national database from 2007-2017 and stratified based on their history of corticosteroid injections within the 6-month preoperative period. Patients who received injections were stratified into biweekly cohorts by the timing of their most recent injection. The 1-year rate of postoperative infection treated by surgical debridement was compared between injection and non-injection cohorts. Univariate logistic regressions of risk factors and a multivariate analysis for patient comorbidities and injection cohorts associated with increased infection risk were conducted.

Results: From the 76,090 TKA patients, corticosteroid injections within 2 weeks prior to TKA increased the risk of postoperative infection ($p=0.02$), and injections within 2-4 weeks trend toward increased infection in univariate regression. No significant differences were observed in any other injection timeframes. In the multivariate analysis (Table 1), injections within 2 weeks prior to TKA were identified as an independent risk factor (OR 2.89; $p=0.04$) for postoperative infection. Additional risk factors included chronic obstructive pulmonary disease, coronary artery disease, diabetes, ischemic heart disease, obesity, rheumatoid arthritis, and tobacco, while female sex and patient age over 65 were protective.

Discussion: Our results suggest that corticosteroid injections administered within 4 weeks prior to TKA may increase postoperative infection risk.

Conclusion: TKA performed within 4 weeks of a corticosteroid injection may be associated with a higher risk of postoperative infection; however, delaying surgery more than 4 weeks may not provide additional risk reduction.

Variables	All Procedures	
	OR (95% CI)	<i>p</i> -value
Injections (0-2 Weeks)	2.894 (1.062 – 7.890)	0.038
Chronic Obstructive Pulmonary Disease	1.391 (1.168 – 1.658)	< 0.001
Coronary Artery Disease	1.422 (0.995 – 2.031)	0.026
Diabetes	1.204 (1.035 – 1.401)	0.016
Hypertension	1.161 (0.967 – 1.395)	0.110
Ischemic Heart Disease	3.212 (1.488 – 6.933)	0.003
Obesity	1.424 (1.197 – 1.694)	< 0.001
Pulmonary Heart Disease	1.422 (0.995 – 2.031)	0.053
Rheumatoid Arthritis	1.622 (1.217 – 2.161)	< 0.001
Tobacco	1.473 (1.099 – 1.975)	0.010
Sex (Female)	0.827 (0.712 – 0.959)	0.012
Patient Age (>65 years)	0.534 (0.439 – 0.650)	< 0.001

Table 1. Multivariate logistic regression of infection controlling for injections received within 2 weeks prior to total knee arthroplasty, chronic obstructive pulmonary disease, coronary artery disease, diabetes, hypertension, ischemic heart disease, obesity, pulmonary heart disease, rheumatoid arthritis, tobacco, sex, and patient age (over 65 years old).

CI = confidence interval, OR = odds ratio

Bold = statistically significant

ID: 56

Negative pressure dressing following stage 1 revision total hip arthroplasty

Herrick Siegel, Matthew Hess, Jeffrey Pearson, Kevin Wall

Background / Rationale: Infected total hip arthroplasty removal with placement of an antibiotic spacer system may be highly complex. The complexity of soft tissue exposure and bone loss often leads to persistent drainage and morbidity. Incisional management may be complicated by drainage and the need for frequent dressing changes may be cumbersome and risk incision contamination.

Study Question: Does a negative pressure dressing benefit patients undergoing stage 1 revision hip surgery and what is the long term consequence of the use of this type of incision management?

Methods: 45 patients that had undergone a 2 stage hip revision for infection were identified and followed for a period of at least 1 year. 26 of these 45 patients were treated with an incisional wound vacuum management system in the immediate post op period. 19 of the 45 were treated with a single indwelling drain with a standard post op dressing. Re-operations, nursing records, and infection outcome were reviewed.

Results: The patients treated with a wound VAC in the immediate post op period required few hospital days, fewer re-operations, and were noted to have fewer recurrences than the group treated without an incisional wound VAC. Twenty four of the 26 patients did not have any evidence of infection at 1 year follow up and 2 patients were continued on oral antibiotic suppression due to persistent elevated markers. In those patients treated with out a VAC, 6 patients returned to the OR for further hematoma evacuation and debridement and 4 of 19 required chronic antibiotic suppression. The hospitalization was also significantly longer in the non-incisional VAC group.

Discussion: Incisional negative pressure dressings are simple to use and improves management of the patient's incision. In this study, a silver coated negative pressure dressing was used followed by biweekly changes of an incisional wound VAC. Patients were treated successfully with the incisional VAC for 1-3 weeks, Without an incisional negative pressure dressing, patient returned to the operating room more often and require higher complexity of nursing care.

Conclusion: Routine use of incisional negative pressure dressings is recommend following stage 1 revision of the hip. It appears to have a significant impact on length of hospitalization, home incisional management and infection outcome. Few complications were seen contributable to the incisional wound VAC system.

ID: 57

Does Chronic Antibiotic Suppression Prior to Girdlestone Arthroplasty Affect Mortality, Reoperation and Complications rates? A Retrospective Review

Ravi Teja Rudraraju, Shane Bross, Christopher Damsgaard, Steven Lietman, James Murphy

Background / Rationale: Resection (Girdlestone) hip arthroplasty (GRA) has historically been used as a treatment for severe, unreconstructable hip disease, however, this procedure is rarely used in modern times. This study reviewed the indications and results of a large series of GRA in the current arthroplasty environment with 1-year follow-up with specific attention to chronic antibiotic usage.

Study Question: An Overview of Indications, Complications and Outcomes following Girdlestone Arthroplasty in the Year 2020. Does Chronic Antibiotic Suppression Prior to Girdlestone Arthroplasty Result in Higher Mortality and Complications rates? A Retrospective Review

Methods: Patients who underwent GRA between 2004 and 2019 were enrolled in the study. Patient demographics, operative indications, co-morbidities and antibiotic history with 90 day and 1-year mortality rates, reoperation percentage and complication rates were analyzed. Preoperative chronic antibiotic suppression and its relationship to survival and reoperation rates was studied.

Results: 92 of 104 total patients met inclusion criteria. The overall mortality rate at the time of study was 38%. Of the 33 patients that died, 27% died within 90 days and 45% died within 1 year of GRA with 63% of cases having confirmed infection at the time of GRA procedure. One in four (26%) patients were on chronic antibiotic suppression prior to GRA and the mortality rate was 43% in this group. Half (50 %) had at least one complication and 12.5% required reoperation. 70% of patients who had a complication post operatively had a history of preoperative narcotic use.

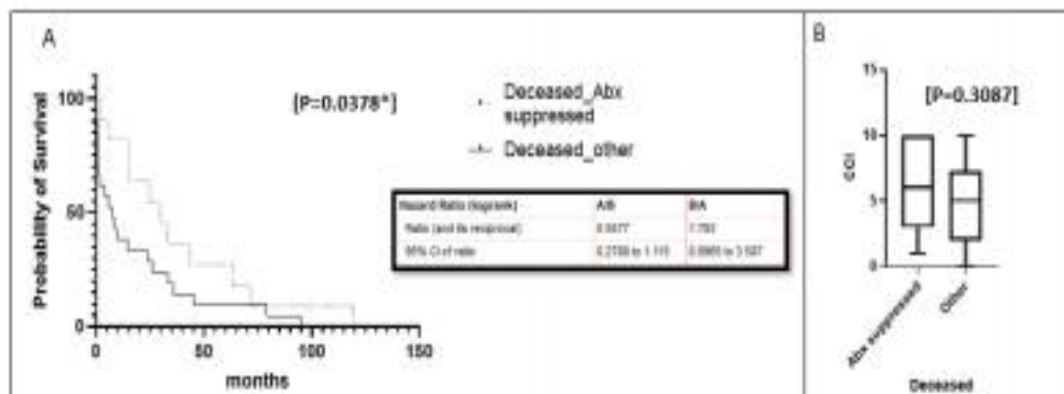
Discussion: Patients who were on chronic antibiotic suppression prior to GRA had an increased mortality rate compared to the overall mortality rate. Of those that did survive, patients on pre-operative chronic suppression seem to survive longer after surgery than those who are not. Patients with Charlson comorbidity index (CCI) score between 0 and 4 survived 4.5 times longer than those with higher CCI.

Conclusion: Our results build on previously published, smaller studies which demonstrate that patients who are being considered for resection arthroplasty have a high mortality rate, high complication rate and are usually infected. Patients on chronic antibiotic suppression have a higher initial mortality rate but survive longer after GRA implying a role for chronic antibiotic suppression.

PATIENT CHARACTERISTICS	% (n)
Total analyzed	88
Females	36% (32)
Males	64% (56)
Age (years) at procedure (mean/median)	59/63
Mean age Female v. Male	67 v. 54
Age range	14 - 96
OPERATIVE CHARACTERISTICS	% (n)
Total GRAs analyzed	92
Right hip	60% (55)
Left hip	38% (35)
Bilateral (single surgical admission)	2% (2)
GRA as primary procedure	57% (52)
GRA as secondary procedure	43% (40)
Re-operation rate (out of 88 patients)	13% (11)
SURVIVAL CHARACTERISTICS	% (n)
Mortality rate	38% (33)
Of those deceased	
Deceased < 90 days post-op	27% (9)
Deceased < 1-year post-op	45% (15)

Table 1. GRA Patient Clinical, Operative, and Survival Characteristics, 2007-2019

Girdlestone resection arthroplasty (GRA)



*Statistically significant

Figure 7. Impact of antibiotic suppression on survival following Girdlestone procedure. (A) Survival analysis of deceased patients demonstrates that those who had a history of chronic antibiotic suppression prior to Girdlestone procedure had significantly improved survival outcomes following surgery. (B) A two-sample independent t-test revealed there was no significant difference between the CCI scores of the two comparison groups.

antibiotic (abx); charlson comorbidity index (CCI)

ID: 61

PhotothermAA Eradicates Bacterial Biofilm in a Rabbit Model of Periprosthetic Joint Infection

Anabelle Visperas, Nicolas Piuze, Minseon Ju, Hiba Anis, Wael Barsoum, Carlos Higuera Rueda, Alison Klika

Background / Rationale: Periprosthetic joint infection (PJI) is a devastating complication of total joint arthroplasty. While research has focused on developing better tests for disease diagnosis, treatment options have stayed relatively constant over the years with high failure rates ranging from 30%-50% and are due in part to the protective biofilm produced by some bacterial species. Current treatment options are compromised by the presence of biofilm, emphasizing the need for novel treatment strategies to be developed. Our group has developed a novel treatment (PhotothermAA) which has demonstrated in vitro its ability to target bacterial biofilm.

Study Question: Does PhotothermAA technology eradicate biofilm in vivo in a rabbit model of PJI?

Methods: Four New Zealand white rabbits were implanted with a titanium tibial implant to mimic a total knee arthroplasty, and inoculated with 5×10^6 CFU of Xen36 (bioluminescent *Staphylococcus aureus*). After two weeks, rabbits underwent an I&D procedure and treated with control hydrogel (n=2) or PhotothermAA (n=2) for two hours. After incubation, gel was heat activated with a laser for ten minutes, washed out, and closed. Rabbits were sacrificed two weeks after treatment for scanning electron microscopy (SEM) biofilm analysis of implant.

Results: All rabbits underwent surgery and treatment without any major complications. SEM images showed that I&D alone was not enough to eradicate bacterial biofilm. Treatment with PhotothermAA completely eradicated biofilm on the head of the implant, the area in direct contact with the PhotothermAA gel and laser treatment (Figure 1). Interestingly, areas not directly in contact with the treatment saw a reduction in bacterial biofilm but effects decreased with distance.

Discussion: PhotothermAA is able to eradicate bacterial biofilm in vivo. Treatment reduction over distance suggests direct contact is not required for treatment effect. This has the potential to become a new treatment strategy for PJI.

Conclusion: PhotothermAA technology is able to target bacterial biofilm in an in vivo model of PJI.

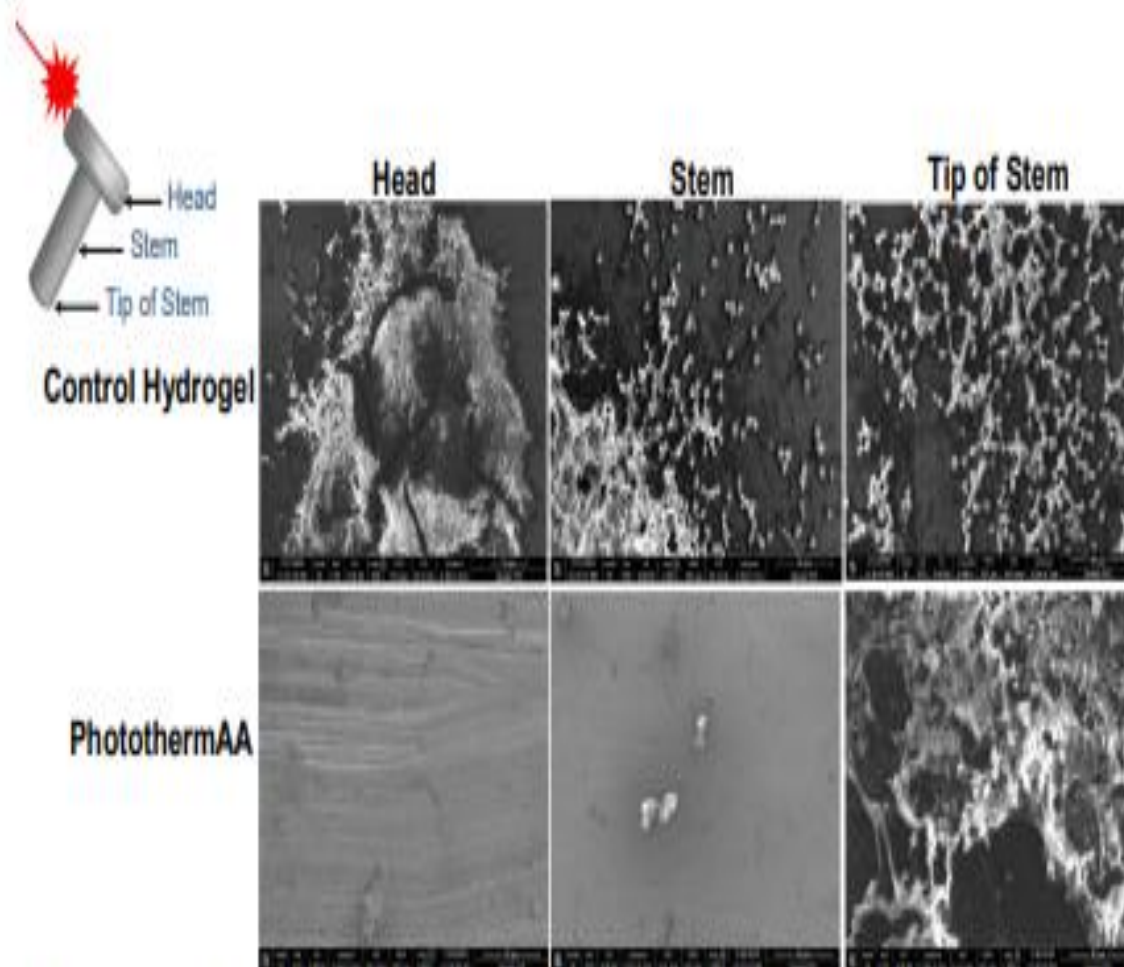


Figure 1. Representative SEM of implant 2 weeks after treatment with PhotothermAA. 1000x magnification. N=4

ID: 62

External Validation of a Preoperative Prognostic Calculator for Periprosthetic Joint Infection

Michael Kheir, Andrew Figoni, Ruben Monarrez, Hannah Szapary, Mitchell Maltenfort, Erik Hansen, Antonia Chen

Background / Rationale: Preoperative calculation of treatment failure risk in patients undergoing surgery for periprosthetic joint infection (PJI) is imperative to allow for medical optimization and targeted prevention. A prognostic model for PJI treatment failure already exists and is based on data from two institutions (area under the curve [AUC] of 0.684 and 0.690) with an overall AUC of 0.690 (95% CI: 0.648-0.733).

Study Question: The purpose of this study was to externally validate the previously established model from two other institutions.

Methods: A retrospective review was performed of 380 PJIs treated at two institutions (Institution 1, n=124; Institution 2, n=256), from 2000-2019. Minimum follow-up was 1 year. The previously studied prognostic model was used to calculate risk of treatment failure, and receiver operating characteristic curves were generated to calculate the AUC for each institution using the prior model.

Results: When externally validating this model to Institution 1, an AUC of 0.795 (95% CI: 0.693-0.897) was found, while Institution 2 had an AUC of 0.59 (95% CI: 0.502-0.683). In a 3-way comparison between the prior model, Institution 1, and Institution 2, we found that Institution 2 differed significantly in regard to multiple demographic factors, infection profile, and comorbidities. Thus, matching was performed for these variables. The prior institutions had an improvement in AUC (0.774 and 0.730), and Institution 1 improved to 0.961.

Discussion: In this cohort study, we were able to externally validate our model at Institution 1, which performed very well. However, Institution 2 had a decreased AUC using the prior model. When matching for certain characteristics at Institution 2, the AUC was observed to increase in the other institutions. This may indicate that for healthier patients, treatment failure is less predictable using our model; pruning these patients out in favor of sicker patients emphasizes the potential impact of comorbidities on PJI prognosis.

Conclusion: Our prognostic model appears to predict outcomes accurately at 3 institutions with similar patient profiles. However, one institution's patient profile differed significantly from the rest and, thus, the model did not perform well in that scenario. The model appears to be more predictive for sicker patients.

Is pre-operative *S. aureus* screening and decolonization effective at reducing surgical site infection in patients undergoing orthopaedic surgery? A systematic review and meta-analysis with a special focus on elective total joint arthroplasty

Ana Ribau, Jamie Collins, Antonia Chen, Ricardo Sousa

Background / Rationale: *S. aureus* is a major pathogen implicated in orthopaedic infections worldwide. Preoperative decolonization has been promoted but different strategies present mixed results.

Study Question: To determine whether *S. aureus* screening and/or decolonization is effective at reducing surgical site infection in orthopaedic surgery, with a special focus on elective total joint arthroplasty, and which pre-operative *S. aureus* screening/treatment strategy is the most cost-effective for TJA.

Methods: PubMed, Ovid Medline, and Cochrane databases were searched on January 1st, 2020, using a systematic strategy. We included papers with data comparing surgical site infection and periprosthetic joint infection rate in orthopaedic surgery and/or elective total hip and knee arthroplasty patients before/after *S. aureus* screening and/or decolonization protocol and papers evaluating the cost-effectiveness of different *S. aureus* screening/treatment strategies.

Results: One thousand two-hundred and sixty papers were screened, and 32 were ultimately included. Results showed an increased risk of developing any infection (relative risk (RR)=1.71±0.16) and *S. aureus* infection (RR=2.79±0.45) after orthopaedic surgery without previous nares and whole-body decolonization. Focusing exclusively on elective TJA there was an increased risk for developing any infection (RR=1.70±0.17) and *S. aureus* infection (RR=2.18±0.41) if no decolonization is performed. All strategies appeared to be cost-effective, although universal decolonization without screening seemed to be the most advantageous.

Discussion: The current paper results are in line with previous systematic review and meta-analysis. We were able to include a large number of studies with several thousand patients and did not limit our report to overall orthopaedic surgical cases but also included subgroup analysis on elective TJA cases. Additionally, this study combined a systematic review investigating the cost-effectiveness of different strategies.

Conclusion: Preoperative *S. aureus* screening/decolonization protocol lowered the risk of infection after elective orthopaedic and TJA surgeries. However, further studies are needed to determine optimal clinical and cost-effective methodologies.

A Treatment Pathway Variation for Chronic Prosthesis-associated Infections

Simon Saner, Hubert Noetzli

Background / Rationale: Prosthetic joint infections (PJI) are not very frequent but are on the rise due to the increasing total numbers of implantations performed. The approach to an infected hip prosthesis remains individualized and involves both surgical and medical treatment with variations depending on the time of implantation, duration and severity of the infection and damaged tissue, as well as the underlying microorganism.

Study Question: Are the results of the treatment pathway variation performed at our institution comparable to the Liestal protocol outcome for chronic prosthesis-associated infections?

Methods: Between 2003 and 2014 32 patients with chronic PJI underwent 33 two-stage exchange interventions using a cement spacer. In contrast to other treatment pathways antibiotic therapy was targeted to the causative microorganism as early as possible, second look surgery was performed after four days and a four-week antibiotic-free window was interposed before definite reimplantation. Thereafter, antibiotic treatment continued for 6 weeks. All patients were followed for a minimum of two years according to a standardized protocol. Parameters investigated were duration of infection-free survival, functional outcome and epidemiological data.

Results: At two years follow-up and at the last follow up (on average 7 years after reimplantation) 100% of patients were free of signs of infection and the mean Harris Hip Score (HHS) was 89.

Discussion: A meticulously performed 2-stage exchange for PJIs with early targeted antibiotic treatment, second look surgery, an antibiotic-free window before reimplantation and a post-surgical antibiotic treatment of medium duration is associated with excellent infectiological and good functional outcome after more than two years follow-up even in chronic PJIs.

Conclusion: The results are at least comparable to the Liestal protocol. The reduction of the time of antibiotic treatment after reimplantation needs definitively to be further investigated.

ID: 68**Utilization of a Distress Thermometer in Prosthetic Joint Infection Combined Clinics**

Allison Lastinger, Matthew Dietz, Matthew Lokant, Benjamin Giertych, Michael Niemann, Ankur Makani, Seneca Williams

Background / Rationale: Combined Orthopaedic/Infectious Disease clinics facilitate care for prosthetic joint infection (PJI) patients similar to coordinated care in cancer centers. The utilization of a standardized distress thermometer (DT) questionnaire assesses the impact of the disease process on a patient. This study evaluated the distress experienced by PJI patients.

Study Question: How much distress do patients experience during the treatment of PJI? If so, what factors contribute to high DT scores?

Methods: We retrospectively reviewed patients in our combined Ortho/ID clinic. In addition to information surrounding their PJI treatment, patients also completed a questionnaire and DT adapted with permission from the National Comprehensive Cancer Network (NCCN). Standard statistical analysis was performed.

Results: From 2018-2020, 263 patients were identified that received treatment in the Ortho/ID clinic. Of the surviving 227 patients, 49% (n=112) completed the DT questionnaire. The heterogeneous patient population was treated with surgically and medically. Patients underwent an average of 4.5 surgeries (95% CI 3.8-5.1) and received 5.9 weeks (95% CI 5.7-6.3) of parenteral antimicrobials. The average distress score was 6.3 (SD 3.2) with feelings of depression (49%) and worry (68%) reported as the most common emotional stressors while pain (69%) and "getting around" (68%) were the greatest physical concerns. Knee fusions reported the highest average DT scores (5.0, SD 1.5); there was no significant difference between surgical interventions. Seventy-eight percent of patients reported a DT score greater than 4. Significant correlations existed between lower HOOS and KOOS Jr scores and worse DT scores ($p < 0.001$). Additionally, longer duration of antibiotics was associated with higher distress scores ($p < 0.03$).

Discussion: Patients with PJI experience similar challenges to patients with cancer. Patients receiving treatment for PJI experience high levels of distress with average DT scores of 6.3 on a scale from 0 to 10 where 10 indicates the highest level of distress.

Conclusion: Using a standardized tool to measure distress, we found that over 75% of patients exhibited a distress level warranting additional support that exists in established cancer centers. Further evaluations should be pursued to better understand the care required by patients being treated for PJI.

Management of Cutibacterium acnes and Total Shoulder Arthroplasty: Has Consensus Been Achieved?

Benjamin Zmistowski, Jonathon Kosco, Jay Keener, Alexander Aleem

Background / Rationale: Periprosthetic joint infection (PJI) of the shoulder continues to complicate otherwise well-functioning total shoulder arthroplasties. Due to the unique characteristics of Cutibacterium acnes, addressing this complication is challenging. In efforts to improve patient care and research efforts, a sub-group of the Second International Consensus Meeting on Musculoskeletal Infection (ICM) generated over 70 recommendations regarding periprosthetic shoulder infection.

Study Question: To determine the impact of the ICM's work and dissemination in clinical practice.

Methods: An electronic questionnaire of 22 questions was administered to members of the ASES. The questionnaire was designed by fellowship trained shoulder and elbow surgeons in conjunction with our institution's microbiology lab director. Questions focused both on diagnosis and management of shoulder PJI and drew from both the ICM consensus statement as well as clinical experience of the questionnaire authors. Results of the survey were used to compare responses between both high-volume and low-volume shoulder arthroplasty surgeons as well as those within an academic versus non-academic practice.

Results: In total 159 individuals responded. Forty-two percent of respondents worked in an academic practice, and over 40% of respondents reported an annual shoulder arthroplasty volume of >100 cases annually. Only two-thirds of respondents reported utilizing the definition of periprosthetic shoulder infection published by the ICM, with one-quarter of respondents stating they had no knowledge of the ICM definition. There was no difference in utilization of the ICM definition for periprosthetic shoulder infection between high-volume and low-volume surgeons. There was similar lack of consensus in questions regarding diagnosis and management of periprosthetic infection, especially with regard to culture methodology and interpretation of culture results.

Discussion: Shoulder periprosthetic infection presents a unique challenge. In order to better understand the challenges of shoulder PJI, we urge all practitioners involved in diagnosis and management of shoulder PJI to evaluate the recommendations from the ICM and begin to practice a more uniform protocol for patients with suspected PJI.

Conclusion: Despite recent attempts to develop a universal definition of PJI in the shoulder, the results of this survey show lack of adoption.

Pre-Operative Antibiotic Exposure is Associated With Increased Infection Burden in a Mouse Model of Prosthetic Joint Infection, an Effect Which is Tempered by Probiotic Use

Troy Sekimura, Alexandra Stavrakis, Rishi Trikha, Danielle Greig, Benjamin Kelley, Zeinab Mamouei, Nicolas Cevallos, Erik Mayer, Nicholas Bernthal

Background / Rationale: Prosthetic joint infection (PJI) is a devastating complication of arthroplasty. Antibiotic use is known to reduce gut microbiome diversity, the consequences of which are not well understood following orthopedic intervention.

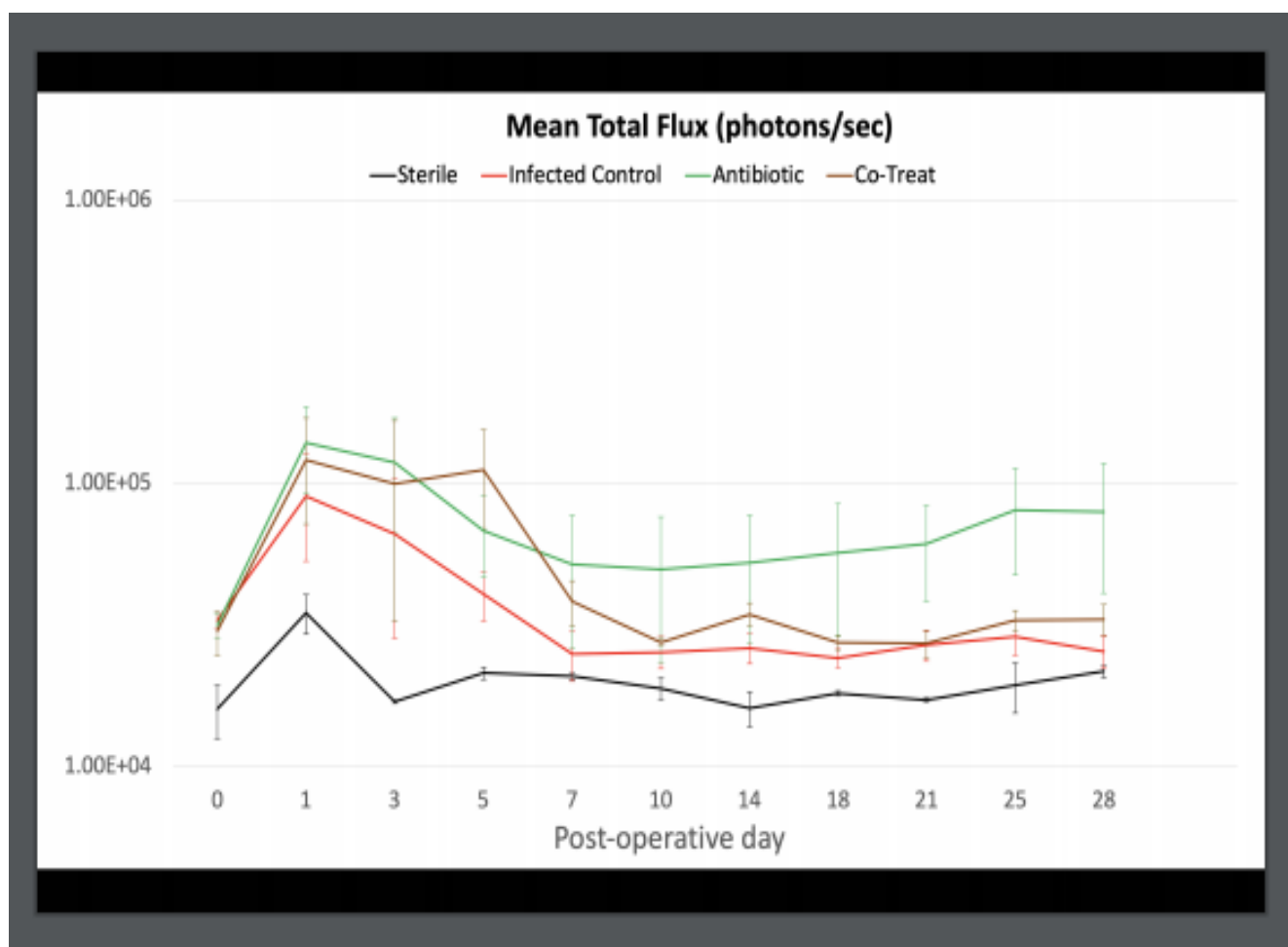
Study Question: Does antibiotic exposure portend increased bacterial burden in PJI, and can this effect be rescued by probiotic use?

Methods: 14 C57BL/6 mice were randomized into four pre-operative treatment groups: four mice received ampicillin and neomycin (Abx group), four received ampicillin, neomycin and probiotics (Co-treat group), and six were untreated, four in an infected control (IC) group and two in a sterile control group. Surgery consisted of placement of a 6 mm titanium pin into the right distal femur with 1 mm of the pin extending into the joint space. Before arthrotomy closure, the exposed pin was inoculated with 1000 colony forming units (CFUs) of bioluminescent Xen36 *Staphylococcus aureus* in the Abx, Co-treat and IC groups. Infection burden was quantified via bioluminescence imaging until post-operative day (POD) 28, and after sacrifice, via CFU quantification of the removed implant and peri-articular tissue.

Results: Bioluminescence in the Abx group exceeded that of the IC group after POD0. Bioluminescence in the Co-treat group was initially similar to that of the Abx group, but by POD10, resembled values seen in the IC group. CFU data showed that implant infection rate was highest in the Abx group. Mean joint tissue bacterial burden was highest in the Abx group (3.86 E4 CFU), followed by the Co-treat (5.81 E2 CFU), IC (6.25 CFU) and sterile (0 CFU) groups respectively.

Discussion: Using an antibiotic regimen shown to significantly reduce gut flora diversity in a mouse model, this pilot study alludes to a relationship between the gut microbiome and infection burden in PJI. Bacterial burden was highest in the Abx group, suggesting that reduced gut flora diversity is associated with increased infection burden. Bacterial load in the Co-treat group approached that of the IC group, suggesting that restoring gut flora diversity may temper the negative impact of antibiotic exposure on bacterial burden in a PJI model.

Conclusion: Antibiotic exposure is associated with increased bacterial burden in a mouse model of PJI. This effect is likely due to decreased gut microbiome diversity, and is mitigated by probiotic use.



Projected Economic Burden of Periprosthetic Joint Infection of the Hip and Knee in the United States

Ajay Premkumar, David Kolin, Kevin Farley, Jacob Wilson, Alexander McLawhorn, Michael Cross, Peter Sculco

Background / Rationale: In addition to the significant morbidity and mortality associated with periprosthetic joint infection (PJI), the cost of treating PJI is substantial. Prior high-quality national estimates of the economic burden of PJI utilize data up to 2009 to project PJI growth in the United States through 2020. Now in the year 2020, it is appropriate to evaluate these past projections and incorporate the latest available data to better understand the current scale and burden of PJI in the United States.

Study Question: What are the current and projected hospital costs associated with PJI in the United States?

Methods: The Nationwide Inpatient Sample (NIS; 2002-2017) was used to identify rates and associated inpatient costs for primary total knee arthroplasty (TKA) and total hip arthroplasty (THA) and PJI-related revision TKA and THA. Poisson regression was utilized to model past growth and project future rates and cost of PJI of the hip and knee.

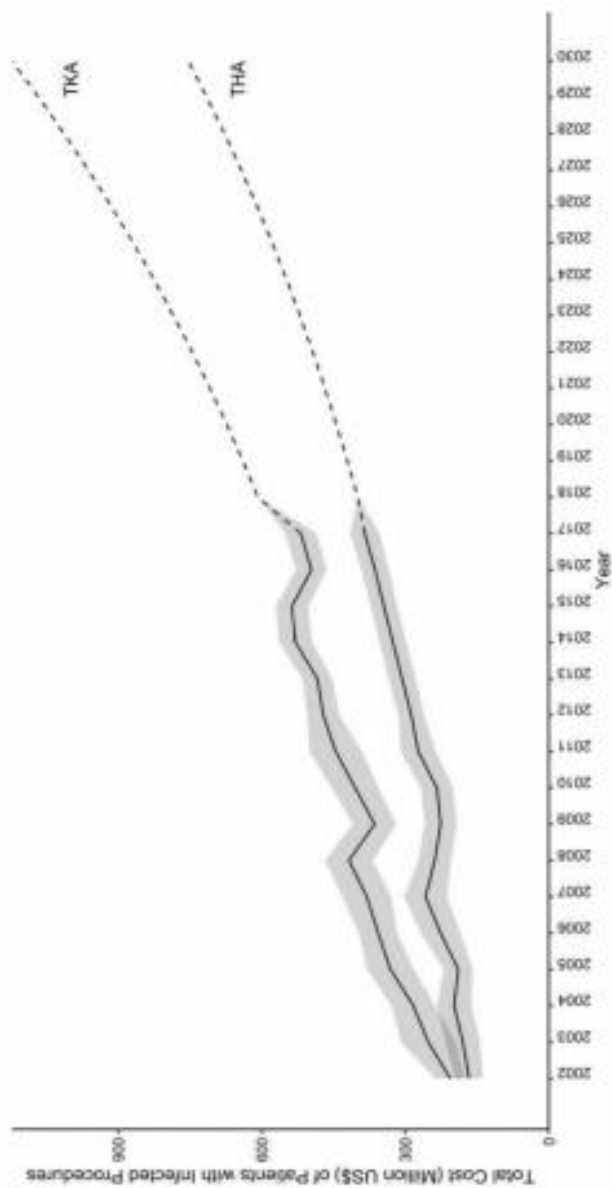
Results: Using the most recent data, the combined annual hospital costs related to PJI of the hip and knee were estimated to be \$1.85 billion by 2030. This includes \$753.4 million for THA PJI and \$1.1 billion for TKA PJI, in that year (Figure 1). Increases in PJI costs are mainly attributable to increases in volume. While the growth in incidence of primary THA and TKA has slowed in recent years; the incidence of PJI and the cost per case of PJI remained relatively constant from 2002-2017.

Discussion: Understanding the current and potential future financial burden of PJI for surgeons, patients, and healthcare systems is essential.

Conclusion: There is an urgent need for efficacious preventive strategies in reducing rates of PJI after total hip and total knee arthroplasty.

FIGURE

Historical and projected cost of PJI-related revision THA and TKA procedures in the United States (2002-2030). The dashed lines represented projected costs per surgery type. The shaded area represents the 95% CIs of the historical data (2002-2017) and the projections (2018-2030).



ID: 81**The Utility Of Leukocyte Esterase Test In Diagnosing Culture Negative Periprosthetic Joint Infections**

Alisina Shahi, Alec Kellish, Ali Oliashirazi, Javad Parvizi

Background / Rationale: Diagnosis of periprosthetic joint infection (PJI) is very challenging especially when the cultures are negative. The Leukocyte Esterase (LE) strip test has emerged as a cost-effective modality for diagnosing PJI and is one of the minor Musculoskeletal Infection Society (MSIS) criteria for the diagnosis of PJI.

Study Question: What is the role of LE strip test in diagnosing PJI in culture negative patients?

The purpose of this study was to assess the performance of the LE strip test in identifying culture negative PJIs.

Methods: We conducted a retrospective study and identified 294 revision arthroplasties that were performed in our institution between 2007-2018. The included patients had negative cultures and available results of LE strip test. Of these patients 43 were infected. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (+LR), and negative likelihood ratio (-LR) were calculated using both the ++ and ++/+ cutoff for the LE strip test.

Results: Using the ++ threshold, LE test had a sensitivity of 30.0%, specificity of 97.1%, PPV of 42.1%, NPV of 95.0%, +LR of 10.3, and -LR of 0.7. When the ++/+ threshold was used the LE test had 95.0% sensitivity, 85.8% specificity, 32.8% PPV, and 99.58% NPV. The +LR and -LR were 6.67 and 0.05 respectively.

Discussion: Based on the findings of this study, the LE test could effectively rule out PJI in culture negative patients given its high NPV and sensitivity and very low -LR. Our results demonstrated that the LE test with ++ threshold has a great specificity with low sensitivity whereas the ++/+ cutoff delivers a high sensitivity but lacks specificity. Currently available LE strip tests are designed based on the quantitative values of the LE activity in urine. This suggests that a synovial fluid specific LE strip test needs to be developed tailored for diagnosing PJIs.

Conclusion: The current strip can be confidently used to rule out PJI in suspected patients with negative cultures.

ID: 82

Serum ESR and CRP are not reliable markers for screening/diagnosing PJI

Alisina Shahi, Alec Kellish, Ali Oliashirazi, Javad Parvizi

Background / Rationale: Based on the recommendations of the American Academy of Orthopaedic Surgeons serum ESR and CRP are the first lines for periprosthetic joint infection (PJI) work up. The studies that shaped these guidelines frequently contained small sample sizes and rarely used a standardized definition of PJI.

Study Question: Thus, the purpose of the paper is to reexamine the sensitivity of serological tests utilizing a contemporary definition of PJI.

Methods: A retrospective review of an institutional database of 689 total joint arthroplasties (368 knees , 321 hips) that underwent surgery for PJI. The modified MSIS definition of PJI, and the defined thresholds for various parameters, were used to categorize patients into infected and non-infected. Sensitivities were calculated for serum CRP among all PJIs, ESR for chronic infections, and for both tests together.

Results: The sensitivity of these markers for diagnosing chronic PJI (defined as infection occurring greater than 6 weeks from index arthroplasty), was 74.3% (95% CI: 67.7-80.9%) for CRP, and 80.0% (95% CI: 75.4-84.6%) for ESR. The sensitivity of these tests combined was 82.5% (95% CI: 73.3-85.7%) for ESR or CRP to be abnormal and 78.4% (72.7-90.6%) for both markers to be elevated. The sensitivity of CRP (threshold of $\geq 100\text{mg/L}$) was 64.2% (95% CI: 61.3-67.1%) for acute PJIs.

Discussion: It appears that serum ESR and CRP have a high false negative rate than previously reported, especially in patients with acute PJIs. Antibiotic administration, PJI with low virulent organisms, and the high thresholds for these tests than previously described may be some of the reasons for the high false negative rate. Current thresholds recommended by the ICM may need to be examined and possibly lowered to improve the sensitivity of these screening tests.

Conclusion: Surgeons should be aware that PJI may still occur despite normal serological tests and should maintain a high clinical suspicion.

ID: 88**Successful culture specimen acquisition aids targeted antibiotic administration in cases of septic arthritis.**

Anne Sullivan, Edward Woods

Background / Rationale: Diagnosis and treatment of septic arthritis (SA), including prosthetic joint infection (PJI), is aided by cultures of the causative organism, facilitating directed antibiotic therapy. Specimens are obtained by aspirating the infected joint, which may require image guidance. Aspiration requiring image guidance is sometimes performed after antibiotics are given, contrary to guidelines, compromising the reliability of the culture and a susceptibility testing. We introduce a succinct surrogate for the process, the Specimen Acquisition Index (SAI), a ratio of time to obtain culture specimen, to time of antibiotic administration. SAI ≤ 1 indicates that the culture specimen is uncorrupted by antibiotics, and should more reliably yield an accurate microbial diagnosis to aid in treatment of SA/PJI.

Study Question: We hypothesized that SAI for infected hips (typically requiring image guidance to aspirate) would less often be ≤ 1 than for infected knees, and the patients with SAI ≤ 1 would more frequently receive antibiotics targeted to organism sensitivity.

Methods: With IRB approval, medical records were searched for adherence to clinical practice guidelines, including relative time taken to aspirate for culture, and to give antibiotics, for joint infection. Selection criteria included synovial fluid aspiration and culture in cases of SA/PJI, in the hip or knee.

Results: We reviewed 36 hips and 76 knees, which were ultimately diagnosed as having SA/PJI. SAI for hips was found to be ≤ 1 in 27% of cases, while SAI for knees was ≤ 1 in 51% of cases. Joints with SAI ≤ 1 were 15% more likely to ultimately receive culture directed antibiotics.

Discussion: The results show a variation in adherence to established clinical practice guidelines, reflected in difference in SAI, between hips and knees. We also show differences in ability to establish culture directed treatment in cases of suspected septic arthritis of hips vs. knees. One potential explanation for this difference is the delay attributed to image guidance for specimen aspiration in the case of hips, suggesting an opportunity for diagnostic process improvement.

Conclusion: We found a significant difference in frequency of SAI ≤ 1 between hips and knees. This seemed to parallel successful culture growth between the two groups of joints, suggesting that recommended diagnostic processes such as clinical practice guidelines facilitate informed antibiotic choice.

ID: 90

Fluorescent angiography in primary and revision knee arthroplasty

Taylor Shackelford, Julie Glener, Joshua Reside, Matthew Dietz

Background / Rationale: While numerous surgical specialties have made technologic advancements to increase operative precision, orthopaedics has no widely-used adjuncts to guide and assess adequacy of debridement during operative treatment of PJI. Laser-assisted fluorescent angiography (LAFA) assesses real-time skin, soft tissue, and bone perfusion, and has proven useful in numerous surgical settings.

Study Question: The purpose of this study is to assess the utility of LAFA in assessing deep tissue and bone perfusion in the setting of primary and revision total knee arthroplasty (TKA).

Methods: Following IRB approval, patients receiving primary TKA (control) or revision TKA for septic and aseptic failure were enrolled in the study. LAFA with parenterally administered indocyanine green dye (ICG) was used to determine pre- and post-debridement perfusion of deep tissue and bone intraoperatively. The absolute and tissue specific ingress and egress values were compared in all patient groups before and after debridement. A matched pair t-test was used to compare changes in these outcomes before and after debridement in each surgical group.

Results: Five primary TKAs were compared to 8 revisions (5 aseptic/3 septic) in the study. An average increase in ICG ingress rate from 2.5 to 11.2 units/second was seen following soft tissue debridement in all groups when compared to pre-debridement values ($p=0.03$). No significant difference was seen in absolute ingress/egress, or egress rate following debridement. In this limited cohort there were no differences in measured parameters between surgical groups.

Discussion: Differences in tissue characteristics pre and post-debridement were detected with the use of intraoperative LAFA. This study demonstrates the feasibility of deep fluorescent angiography and that it is a tool worth exploring to provide quantitative assessment regarding adequacy of debridement during revision TKA.

Conclusion: LAFA shows promise as an adjunct during debridement for PJI, and further research needs to be conducted regarding the clinical impact guided debridement could provide.

ID: 91

Comparison of Infection Eradication Rates in Chronic Prosthetic Knee Infections Treated with Articulating vs. Static Antibiotic Cement Spacers

Jaclyn Jankowski, David Keller, Luke Menken, Frank Liporace, Richard Yoon

Background / Rationale: In the United states chronic prosthetic knee infections are most commonly treated with two-stage revisions utilizing articulating or static antibiotic cement spacers. Current literature shows that articulating antibiotic cement spacers tend to have improved knee society scores and range of motion when compared to static spacers.

Study Question: The purpose of our study is to examine the difference in rates of infection eradication in chronic prosthetic knee infections treated with articulating vs. static antibiotic cement spacers.

Methods: This is a retrospective review of 64 patients at a single institution with chronic prosthetic knee infections treated with two-stage revisions and placement of either an articulating or static antibiotic cement spacer from 2017-2020 . Inclusion criteria to receive an articulating spacer were first time failures with minimal bone loss, while inclusion criteria to receive a static spacer were those with multiple failures due to infection and more severe bone loss.

Results: 64 patients were included in the study, of which 18 received articulating spacers and 46 received static spacers. Those treated with articulating spacers showed infection eradication in 88.9% while those treated static spacers had an eradication rate of 71.1%, though this was not a significant difference. In the articulating spacer group only 38.89% had undergone two or more prior procedures for infection, compared to 82.22% in the static spacer group ($p=0.002$). Additionally, significantly more patients in the static spacer group received intramedullary antibiotic loaded calcium sulfate ($p=0.052$) and treatment with the reamer irrigator aspirator (<0.001).

Discussion: While static antibiotic cement spacers were placed in patients who had been operated on significantly more times due to history of multiple infections, and were more often supplemented with use of the reamer irrigator aspirator and antibiotic loaded calcium sulfate in the medullary canal, infection eradication rates were not significantly different from those treated with articulating antibiotic cement spacers.

Conclusion: There is no significant difference in infection eradication rate of chronic prosthetic knee infections treated with either static or articulating antibiotic cement spacers.

ID: 93

Butyrate Improves Response to Periprosthetic Joint Infection in Mice with Compromised Gut Microbiome

Gang Ji, Xu Yang, Mathias Bostrom, Alberto Carli, Christopher Hernandez

Background / Rationale: Reducing PJI incidence below 1-2% may require addressing patient factors that influence infection. The microbiome is a modifiable patient factor. Mice with an impaired gut microbiome (DMicrobiome) are more susceptible to PJI and as indicated by an increase in incidence from 50% to 73% (Fig. 1A, Hernandez et al. 2019 CORR). Here we test the idea that a microbiome-derived intervention can address the effects of an adverse gut microbiome on PJI.

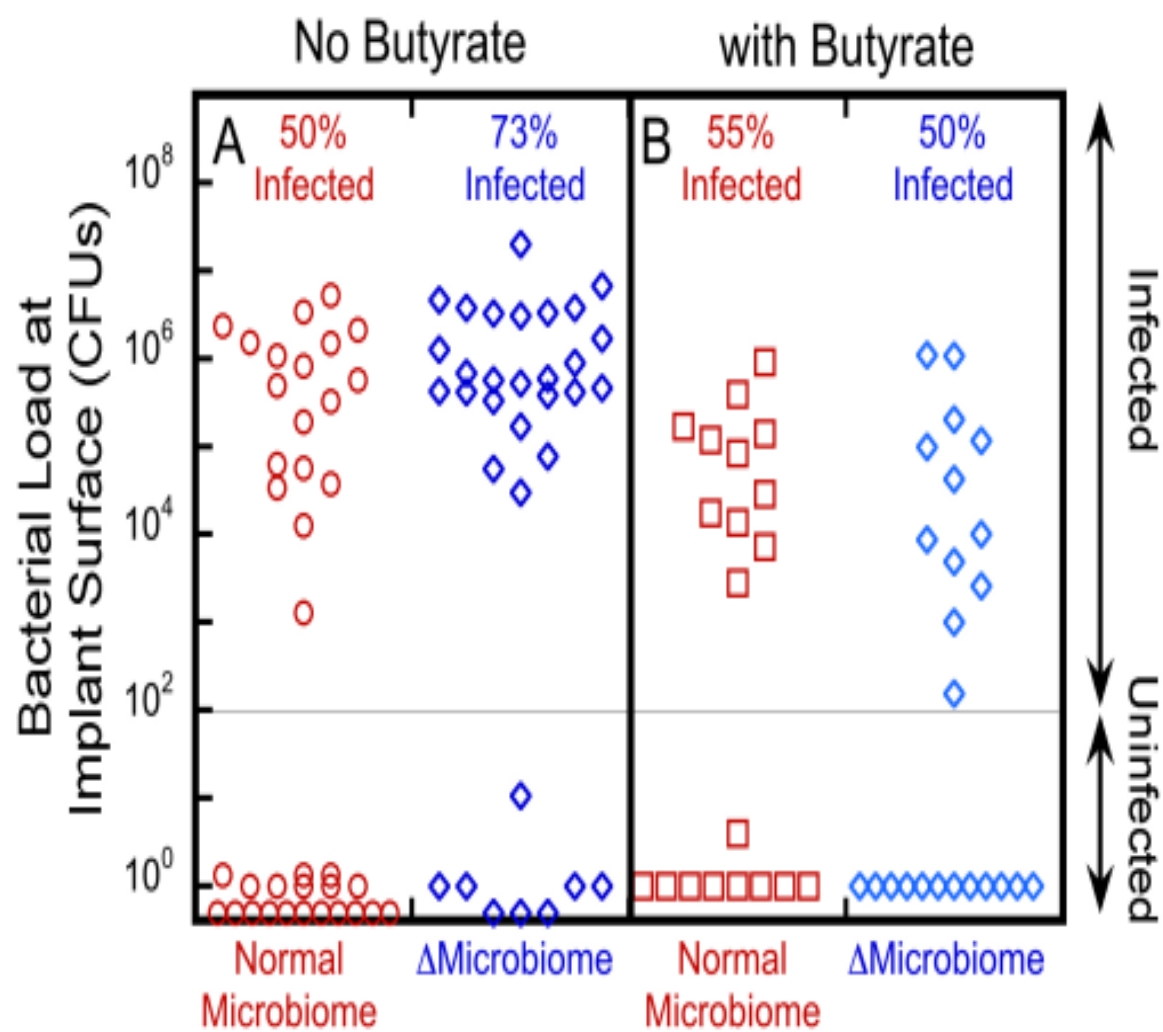
Study Question: Does supplementation with butyrate, a short chain fatty acid produced by beneficial gut microbes, influence susceptibility to PJI in mice with impaired gut microbiota?

Methods: At weaning, male C57Bl/6 mice were separated into two groups: a normal gut microbiota group (Normal Microbiome, n=20) or an impaired gut microbiota group (DMicrobiome, n=24). The microbiome was altered by adding ampicillin and neomycin into drinking water from 4-16 weeks of age. At 14 weeks of age, drinking water was further altered to include butyrate (100mM, both untreated or with antibiotics). At 16 weeks of age, animals were submitted to surgical insertion of a titanium tibial implant followed by an inoculation of 10^2 CFUs of *S. aureus* (Xen 36) into the joint space. Five days after surgery/inoculation animals were euthanized and CFU counts were performed to assess infection.

Results: No differences in animal health (body weight, cage activity, etc.) were associated with supplementation with antibiotics or butyrate. The bacterial load at the implant surface ranged from zero to 10^6 CFUs (Fig. 1B). As in prior work, an implant CFU count exceeding 10^2 CFUs was indicative of established infection. The proportion of animals in the butyrate treated ?Microbiome group developing infection (12/24, 50%) did not noticeably differ from the group with a normal microbiome (11/20, 55%, $p=0.89$, Fig. 1B).

Discussion: Although oral butyrate is not used clinically (poor patient compliance), increased production of butyrate by the gut microbiome is a major beneficial effect of probiotics, suggesting that oral probiotics have the potential to improve the response to PJI in individuals with compromised gut microbiota. Microbiome based interventions, applied in a short period time prior to surgery may mediate the effect of an adverse gut microbiome.

Conclusion: In mice, two weeks of oral butyrate prevented the effects of an impaired gut microbiome on PJI.



ID: 95

What Is the Impact of Rheumatoid Arthritis and Systemic Lupus Erythematosus on in Hospital Complications after Total Hip Arthroplasty?

Alisina Shahi, Jack Shilling, Lawrence Miller, Ali Oliashirazi, Alec Kellish

Background / Rationale: Rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE) are autoimmune disorders characterized with systemic inflammation, damaging joints. While many patients with RA/SLE develop arthritis, newer medications may reduce the rate of arthroplasty procedures required by these patients. This study investigates the in-hospital mortality and complication rates, and trends of total hip arthroplasty (THA) in patients with SLE or RA.

Study Question: What is the change in the rate of in-hospital complications and mortality in patients with RA and SLE after total hip arthroplasty from 2000 to 2015?

Methods: The Nationwide Inpatient Sample from 2000-2015 was queried for THA then stratified by diagnoses of RA or SLE to determine the incidence of in-hospital mortality and complications including myocardial infarction, deep venous thrombosis, and sepsis. Chi-square, ANOVA, and multivariate logistic regression were used to compare these variables between the surgical interventions.

Results: From 2000 to 2015, 881,058 THA were performed; 25,448 (2.89%) had RA, 4,344 (0.49%) had SLE, and 807 (0.09%) had both SLE/RA. The number of procedures performed increased by 2.72% per year overall: 2.72% (without RA or SLE), 1.89% (RA), and 1.17% (SLE). Mortality rate for patients without RA or SLE (0.223%) was no different than with SLE (0.301%, OR=1.35, 95% CI=0.78-2.33), but slightly higher than rates in patients with RA (0.13%, OR=0.58, 95% CI=0.41-0.82). Patients with SLE were more likely than patients without RA/SLE to experience any complication (OR=1.68, 95% CI=1.48-1.87), joint infection (OR=3.0, 95% CI=2.24-4.00), sepsis (OR=3.00, 95% CI=1.70-5.32), and UTI (OR=1.50, 95% CI=1.31-1.76). Cost and LOS in patients without RA/SLE is (Mean: \$56,097, 3.68 days), less than RA patients (Mean \$57,397, 3.89 days, $p<0.001$) and SLE (\$61,186, 4.3 days, $p<0.0001$).

Discussion: Over the 15-year study period, the rate of THA increased in for all patients. Patients with SLE undergoing THA had higher rates of in-hospital complications, but no difference mortality rate.

Conclusion: Surgeons must be aware of underlying medical conditions such as RA/SLE, and medications used to control disease symptoms to optimize patients preoperatively.

In-Hospital Complications after Primary and Revision Fusions: Spinal Level's Impact

Alisina Shahi, John Gaughan, Rakesh Mashru, Vishal Khatri, Alec Kellish

Background / Rationale: Rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE) are autoimmune disorders causing systemic inflammation accelerating degenerative changes in the spine. While medications can mitigate the damage, they can complicate surgical management due to immunosuppressive nature. We aimed to investigate the in-hospital mortality and complication rates, as well as trends of primary and revision cervical (PCF/RCF), thoracic (PTF/RTF), and lumbar (PLF/RLF) fusions in RA/SLE patients.

Study Question: What is the change in the rate of in-hospital complications and mortality in patients with RA and SLE after primary and revision spinal fusions from 2000 to 2015?

Methods: The Nationwide Inpatient Sample from 2000-2015 was queried for primary and revision fusions of the cervical, thoracic, and lumbar spine then stratified by diagnoses of RA or SLE to identify and determine the incidence of in-hospital mortality and complications including myocardial infarction, deep venous thrombosis, and sepsis after fusions. Chi-square, and ANOVA were used to compare these variables between procedures.

Results: From 2000-2015, 488,420 PCFs/RCFs, 630,510 PLFs/RLFs, and 79,347 PTFs/RTFs were performed with approximately 1.98%, 2.48%, and 1.82% of SLE/RA undergoing each procedure. There was no difference in the rate of in-hospital mortality for any procedure between patients with and without RA/SLE. RCFs SLE patients had higher incidences of accidental laceration/puncture (OR=4.66, 95% CI:1.12-19.27), pulmonary edema (OR=9.74, 95% CI=5.42-444.20), and sepsis (OR=1.85, 95% CI: 1.11-3.08). SLE Patients had higher rates of sepsis (OR=2.31, 95% CI: 1.24-4.32), and UTI (OR=1.32, 95% CI: 1.04-1.68) after PLFs, and overall complications (OR=7.39, 95% CI: 1.01-54.58), and CVA (OR=7.39, 95% CI: 1.01-54.58) after RLFs. Cost was significantly greater in patients with RA for all procedures PTFs, and all procedures except RTFs and RCFs in patients with SLE.

Discussion: Based on the findings of this study it was shown that RA/SLE patients had more costly episodes of care, and SLE patients had higher incidences of in-hospital complications.

Conclusion: We encourage the orthopaedic community to be cognizant of these complications and optimize the patients to improve outcomes.

Investigation of the immune milieu in the acute phase of periprosthetic joint infection in a clinically representative mouse model

Sita Nirupama Nishtala, Upneet Sokhi, Yunwei Xia, Xu Yang, Lionel Ivashkiv, Mathias Bostrom, Alberto Carli

Background / Rationale: Local immune response to chronic periprosthetic joint infection has been studied using multiple animal models, however little is known about the local and systemic immune response in the early stages of infection. Using a mouse model, this study investigates the response of the immune system within 72 hours of significant trauma of surgery and induced *S. aureus* infection.

Study Question: How does the local immune response to *S. aureus* infection differ from the systemic response, and how are the bacteria spatially distributed in the bone/joint capsule?

Methods: *S. aureus* (Xen36) was used to infect C57BL/6 mice that received a proximal tibial Ti-6Al-4V implant in the right knee. Mice were euthanized 72 hours after surgery, blood collected via cardiac puncture, the inguinal and parailiac lymph nodes(LN), spleen and knee joints were harvested. LNs and spleen were either immediately processed and analyzed by flow cytometry and the knee joints were fixed and sectioned for histological staining. Implants were collected from infected animals, sonicated and plated to assess bacterial growth using colony forming units (CFU) counting.

Results: All of the animals that received bacterial inoculation were uniformly infected as confirmed by CFU counting. Histological examination of the knee joints revealed that the infected knee joints showed active staphylococcal abscesses within the periprosthetic space, a large number of infiltrating PMNs around the implant, with no osseointegration. Local immune response to infection was evident in significantly higher numbers of dendritic cells(CD11c+,MHCII+) in infected vs non-infected mice within the inguinal LNs. Systemic effects were investigated in the parailiac LNs and spleen both of which show significantly higher number of neutrophils(Ly6C+,Ly6G+) in infected vs non-infected mice. The parailiac LNs also show higher numbers of T cells including CD4 cells(CD4+,TCR??+), T regulatory cells(CD25+,Foxp3+) and follicular T-helper cells(CXCR5+,ICOS+).

Discussion: This study is a first step in understanding immune cell activation in a reproducible mouse model of infection. Significantly higher numbers of activated T cells were observed in the parailiac LNs of infected animals suggesting the activation of immune cell populations to help fight infection.

Conclusion: This work has potential for clinical impact by enhancing our understanding of PJI in its earliest stages.

ID: 100**Sonication cultures of aseptic hip and knee revisions help predict PJI at any threshold**

Rebecca Minorini, Alan Wilson, Michael O'Malley, Kenneth Urish, Brian Hamlin, Brian Klatt

Background / Rationale: Sonication of explanted total joint arthroplasty components improves culture yields when diagnosing periprosthetic joint infection (PJI). The utility of routine sonication for patients undergoing presumed aseptic revisions is poorly understood, specifically whether positive sonication predicts future PJI and need for treatment.

Study Question: 1) Do positive sonication cultures during aseptic revision correlate with risk of future PJI? 2) Does a cutoff threshold of 1, 5 or 10 CFU affect predictive value of sonication in PJI development? 3) Do organisms initially detected on sonication culture predict eventual infecting organisms? 4) Does antibiotic therapy in cases of positive sonication affect rates of PJI?

Methods: This was a retrospective chart review of 1159 patients undergoing presumed aseptic total hip or knee revisions between 2013 and 2018. Exclusion criteria included follow-up of less than 2 years, 2-stage procedures, PJI occurring after subsequent operation, and cases meeting MSIS definition of PJI preoperatively. 299 cases remained, with 45 cases of positive sonication (15.0%). We used the Fisher exact test to compare outcomes.

Results: Positive sonication at any threshold was statistically significant ($p=0.016$) in comparing rates of future PJI, when compared to cases with negative sonication (see Table 1). Analyses comparing thresholds of 0-4 CFU vs. 5+ CFU ($p=0.038$), and 0-9 CFU vs. 10+ CFU ($p=0.002$) were also statistically significant. Sonicate organism growth was not predictive of eventual infecting organism in PJI. Of the 8 cases with positive sonication and PJI development, one was caused by the same organism (coagulase-negative Staphylococci/CoNS). 57.8% of positive sonication cases were not treated with antibiotics (26 of 45). Of these cases, 2 developed PJI (7.7%), including one with 1 CFU Peptostreptococcus, and one with 100 CFU CoNS.

Discussion: Sonication at any CFU threshold is useful in predicting development of PJI in cases of presumed revisions, but not helpful in guiding antibiotics. Most cases of positive sonication without antibiotic therapy do not develop PJI, but a course of broad-spectrum antibiotics for any case with positive sonication after sterile revision is prudent.

Conclusion: Sonication is useful in predicting development of PJI, but not in guiding antibiotic therapy. Further investigation is needed to understand longer term outcomes after sterile revisions.

Sonicate CFU	Developed PJI	Did not develop PJI
0	16	238
1-4	5	30
5+	3	7

Table 1. Case outcomes broken down by CFU on sonication

ID: 101

Cell Count Poorly Predicts Septic Arthritis in Presence of Gout

T. David Luo, D. Landry Jarvis, Hunter Yancey, Andrey Zuskov, Shane Tipton, Maxwell Langfitt, Johannes Plate

Background / Rationale: A synovial cell count greater than 50,000/mm³ is the threshold most commonly used to diagnose septic arthritis. This lab value may be nonspecific in the setting of crystalline arthropathy.

Study Question: The purpose of this study was to evaluate the accuracy of diagnosing septic arthritis using a synovial cell count cut-off of 50,000/mm³ in the setting of crystalline arthropathy.?

Methods: This was a retrospective review of joint aspirations performed between July 1st, 2013 and June 30th, 2016. Synovial fluid samples were evaluated for cell count, crystals, Gram stain, and culture. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the synovial markers were calculated.

Results: During the study period, 738 joint aspirations were sent for testing, of which 358 aspirations in 348 patients met inclusion criteria. There were 49 (13.7%) cases of culture-positive septic arthritis in a native joint, and 47 patients underwent surgical irrigation and debridement. Gout and pseudogout crystals were present in 163 aspirates (45.5%). Three joints (0.8% overall rate) had concomitant crystalline arthropathy and septic arthritis, each of which had a synovial WBC >85,000/mm³. Synovial WBC count of threshold 50,000/mm³ yielded a sensitivity of 61.2%, specificity of 79.9%, and overall accuracy of 77.4% in diagnosis of septic arthritis. Increasing the WBC count cutoff to 85,000/mm³ demonstrated a specificity of 100%, but a PPV of 12.0%.

Discussion: Using a synovial WBC cut-off of 50,000/mm³ in the setting of crystalline arthropathy, the false positives outweigh the true positives by a factor of 16:1, which may lead to surgery in 17 patients with gout/pseudogout to treat one patient with superimposed infection.

Conclusion: Due to the rarity of concomitant septic and gouty arthritis, our proposed algorithm recommends medical management and observation in patients with crystal-positive joint aspirations unless the synovial WBC count is elevated above 85,000/mm³.

Laboratory-Reported Test Cutoffs Do Not Correspond to PJI Scoring System Recommendations

Salvador Forte, Joseph D'Alonzo, Zachary Wells, Brett Levine, Alexander McLaren, Carl Deirmengian, Stephen Sizer

Background / Rationale: Multicriteria tools to diagnose periprosthetic joint infection (PJI), like the International Consensus Meeting on Musculoskeletal Infection (ICM) 2018, include traditional tests which are not designed or intended to diagnose PJI (ESR,CRP,D-Dimer,Synovial WBC, and PMN%). The normal ranges for these tests can vary by laboratory and are not laboratory-validated for the diagnosis of PJI.

Study Question: Our purpose was to determine 1) the variation in reported cutoff values for these tests across US laboratories and 2) the concordance with 2018 ICM recommendations for PJI.

Methods: The normal range (value and units) for serum ESR, CRP, D-Dimer and synovial WBC, PMN%, were compiled from 85 laboratories (41 academic, 44 community) in 19 states and compared to threshold values in the ICM 2018 recommendations for PJI (ICM2018). Laboratory reported thresholds were then applied to a database of patient laboratory data, to identify the percentage of laboratory reports that contradict the ICM guidelines, potentially misleading ordering physician.

Results: All 85 Laboratories utilized the same units of measure to report the ESR, synovial WBC, and PMN%; CRP was reported in 2 different units and D-Dimer was reported in 8 different units. The observed high/abnormal cutoffs reported by laboratories were: ESR (mean=19.8mm/hr; range=10-39); CRP (mean=6.8mg/L; range=2.9-10); D-Dimer (mean=316.6ug/L; range=200-680); WBC count (mean=80cells/ul; range=0-499); and PMN% (mean=25%; range=24-25%). The mean laboratory ESR,CRP,D-Dimer, WBC count, and PMN% cutoffs were 34%, 32%, 63%, 97%, and 64% lower than the ICM recommended cutoffs for PJI. Application of the reported laboratory cutoffs to a patient database of laboratory results yielded a mean false high/abnormal reporting rate of 11%, 12%, 32%, 73%, and 27% for each respective test.

Discussion: Physicians should not trust laboratory-reported qualitative results (normal vs. high) when interpreting traditional tests for PJI. Instead they must convert the raw result to ICM units and apply the ICM recommended cutoff to avoid a high rate of false-positive interpretation. Authoritative bodies should alert physicians that laboratory-reported results cannot be utilized when diagnosing PJI.

Conclusion: Laboratory test cutoffs do not correspond to PJI scoring system recommendations, such as ICM 2018; potentially leading to high false-positive results.

Risk Factors for Developing Peri-Prosthetic Joint Infections Following Primary Total Hip Arthroplasty for Femoral Neck Fractures

Rushabh Vakharia, Matthew Ciminero, Angelo Mannino, Mitchell Ng, Martin Roche, Michael Mont, Kevin Kang

Background / Rationale: Despite favorable outcomes of primary total hip arthroplasty (THA) for the treatment of femoral neck fractures, studies comparing patient demographics and patient-related risk factors for developing peri-prosthetic joint infections (PJIs) following primary THA for these injuries are limited.

Study Question: Therefore, the purpose of this study was to: 1) compare patient demographics among patients who developed and did not develop PJIs; and 2) identify patient-related risk factors for PJIs.

Methods: An administrative claims database was utilized to identify all patients who underwent primary THA for femoral neck fractures from 2005 to 2014. The inclusion criteria for the study group consisted of patients who developed PJIs within 1-year following the index procedures; whereas, patients who did not develop PJIs served as controls. The query yielded 56,075 patients. Endpoints of the study were to compare patient demographics and identify patient-related risk factors for developing PJIs within 1-year following the index procedure. Multivariate binomial logistics regression analysis was used to calculate the risk associated with developing PJIs. A p-value less than 0.001 was considered statistically significant.

Results: Study group patients were significantly different compared to controls with respect to age ($p < 0.0001$) and sex ($p < 0.0001$). Patients who developed PJIs had significantly higher prevalence of comorbid conditions. This is further supported since comorbidity burden was higher in patients who developed PJIs based on mean ECI scores (11 vs. 8; $p < 0.0001$). Additionally, the patient-related risk factors associated with the greatest odds (OR) of PJIs following primary THA for femoral neck fractures was pathologic weight loss (OR: 3.14, $p < 0.0001$), electrolyte and fluid imbalance (OR: 2.69, $p < 0.0001$), depression (OR: 1.73, $p < 0.0001$) and other risk- factors (Table 1).

Discussion: With the rising utilization of primary THA for femoral neck fractures, we found the greatest risk factors associated with developing PJIs was pathologic weight loss, electrolyte and fluid imbalance, and depressive disorders.

Conclusion: The study is vital as it can be used by orthopaedists to adequately counsel and educate these high-risk patients of the potential complications which may occur following their procedure.

ID: 104

Higher Altitude Is an Independent Risk Factor For Infections Following Primary Total Hip Arthroplasty

Rushabh Vakharia, Angelo Mannino, Mitchell Ng, Martin Roche, Michael Mont, Orry Erez

Background / Rationale: Studies have shown surgical procedures performed at higher altitude are at risk for developing adverse events post-operatively; however, this association has not been properly investigated in patients undergoing primary total hip arthroplasty (THA).

Study Question: Therefore, the purpose of this study was to determine whether patients undergoing primary THA at an elevation higher than 4,000 feet (ft) have higher rates of: 1) surgical site infections (SSIs); and 2) peri-prosthetic joint infections (PJIs) within 90-days following the index procedure.

Methods: Patients undergoing primary THA at an elevation higher than 4,000 feet (ft) were identified and matched to a control population undergoing primary THA at an elevation less than 100ft by age, sex, and medical comorbidities – chronic obstructive pulmonary disease (COPD), depression, diabetes mellitus, hyperlipidemia, hypertension, obesity, and tobacco use. These elevations were chosen as studies have shown these elevations to be critical thresholds in developing adverse events following total joint arthroplasty. The query yielded 149,719 patients in the study (n = 24,958) and control (n = 124,765) cohort. Primary outcomes analyzed included comparing 90-day rates of developing SSIs or PJIs. Logistic regression analyses was utilized to calculate odds-ratios (OR), 95% confidence intervals (95%CI), and p-values on the effects of elevation on the dependent variables measured within the study.

Results:

Patients undergoing primary THA at an elevation higher than 4,000 ft had a higher incidence and odds of SSIs (1.16 vs. 0.86%; OR: 1.34, 95%CI: 1.17 – 1.53, p<0.0001) and PJIs (0.91 vs. 0.58%; OR: 1.56, 95%CI: 1.34 – 1.81, p<0.0001) within 90-days following the index procedure.

Discussion: Adjusting for age, sex, and medical comorbidities, the study demonstrated primary THA performed at higher altitudes is associated with a higher risk of infections compared to patients at lower altitudes.

Conclusion: In the era of bundled payments, minimizing the incidence of adverse events is critical. The study can be utilized by orthopaedic surgeons to counsel and educate these patients of the potential complications which may occur following their procedure

Ultrasound Guided Corticosteroid Injections Prior to THA are Associated with Lower Risk of Periprosthetic Joint Infection than Fluoroscopically Guided Injections

Nathan Varady, Christopher Fang, Ahab Chopra, David Freccero, Antonia Chen, Eric Smith

Background / Rationale: While several studies have assessed patient satisfaction and radiographic accuracy of ultrasound-guided intraarticular corticosteroid injections (UG-CSIs) compared to fluoroscopically-guided (FG)-CSIs, the relative infection-risk of these interventions is unknown.

Study Question: The purpose of this study was to assess the rate of periprosthetic joint infection (PJI) after total hip arthroplasty (THA) for patients undergoing preoperative UG-CSI or FG-CSI compared to those not undergoing preoperative CSI.

Methods: This was a retrospective cohort-study of patients undergoing primary, elective THA in the MarketScan database from 2007-2017. All patients had 1-year of continuous enrollment prior to and 6-months following THA. Patient demographics, geography, medical/surgical details, and CSIs (including drug, dose, guidance, timing, and laterality) were collected. Patients who received CSI within 3-months and >3-12 months preoperatively were compared to those who did not. Patients receiving both types of injections were excluded. Chi-squared tests and multivariable logistic regressions were used to assess the association between CSI and PJI within 6-months postoperatively.

Results: There were 5,864 patients undergoing image-guided CSI (59.2% FG-CSI, 54.8% female, mean[SD] age 56.0 [6.3] years). Patients receiving CSI 3-12 months preoperatively had similar PJI rates as those who did not receive CSI (1.28%) for both FG-CSI (1.32%, $p=0.88$) and UG-CSI (1.36%, $p=0.79$). For patients who received CSI ≥ 3 months preoperatively, PJI rates were significantly higher than those who did not receive CSI for FG-CSI (2.47%, $p<0.001$), but not UG-CSI (1.39%, $p=0.76$). Results held in adjusted analysis (FG-CSI ≥ 3 months, OR 1.93 [1.32-2.83], $p<0.001$; UG-CSI ≥ 3 months, OR 1.08 [0.61-1.91], $p=0.79$).

Discussion: In contrast to FG-CSIs, UG-CSIs were not associated with significantly higher rates of PJI when administered within 3-months of THA. While CSIs should typically be avoided within 3-months of THA, UG-CSIs may be preferable to FG-CSIs in this scenario. Future work could consider comparing FG-CSI between patients receiving no, gadolinium-based, and iodine-based contrast.

Conclusion: When administered within 3-months of THA, UG-CSIs are associated with lower risk of PJI than FG-CSIs.

ID: 109**Hepatitis C Treatment Success in Viral Eradication Prior to Elective Total Joint Arthroplasty Reduces Risk of PJI**

Kyle Cichos, Antonia Chen, Erik Hansen, Eric Jordan, Kian Niknam, Gerald McGwin Jr, Joshua Stripling, Elie Ghanem

Background / Rationale: Patients with Hepatitis C (HCV) undergoing primary elective TJA are at increased risk of PJI, but infection rates can be improved with treatment. We hypothesized that successful treatment of HCV (undetectable viral load [VL]), regardless of treatment type, prior to elective TJA would result in significant reduction of PJI.

Study Question: Does HCV treatment success prior to elective TJA decrease the risk of PJI, and is there an optimal time duration from treatment success to TJA?:

Results: There was no difference between the two groups in BMI, comorbidity, Childs Pugh Class, liver fibrosis stage, liver fibrosis activity level, operative duration, blood loss, blood transfusion rate, ICU stay, or discharge disposition. The two groups differed in HCV genotype ($p=0.01$) and MELD level ($p=0.01$). There was no difference between the groups in 90-day or 1-year mechanical complications. HCV patients with positive VL had higher rates of 1-year PJI (9% vs 1%, $p=0.021$). The mean time from 0 VL to TJA for the undetectable VL patients was 34 months (3-242 months; all achieved sustained virologic response [SVR]), and the single PJI case completed treatment 6 months prior to surgery.

Discussion: HCV patients with positive VL at time of TJA are at an increased risk for PJI compared to those with undetectable VL, and HCV treatment type has no impact on outcomes after TJA. There does not appear to be a relationship between time from treatment success to TJA for risk of PJI, though we are likely underpowered for this portion of the analysis.

Conclusion: HCV patients should undergo successful treatment prior to elective TJA. Surgeons should wait until confirmation of SVR (VL remaining undetectable ≥ 12 weeks after completing treatment) prior to performing elective TJA to avoid the possibility of the patient having relapsed prior to surgery.

Relative Risk for PJI in HCV patients with Positive Viral Load compared to those with Undetectable Viral Load at time of TJA

Outcome	Viral Load Positive (n=97)	Viral Load Undetectable (n=84)	Relative Risk	95% CI	p-value
90-day PJI, n (%)					
90-day	7 (7)	1 (1)	6.06	0.76-48.27	0.089
1-year	9 (9)	1 (1)	7.79	1.008-60.25	0.049
5-year	12 (12)	3 (4)	3.46	1.012-11.86	0.048

Abbreviations: PJI, periprosthetic joint infection; HCV, Hepatitis C; TJA, total joint arthroplasty; 95% CI; 95% confidence interval

Prevalence of PJI Pathogens

Levi Riley, Paulo Castaneda, Michael Duran, Cynthia Overstreet, Carl Deirmengian, Alex McLaren

Background / Rationale: Periprosthetic infection PJI is caused by a spectrum of biofilm forming microorganisms has historically been compiled from pathogens identified in outcomes studies. There is no good source of PJI pathogen prevalence across the United States or over time. The data management systems in clinical laboratories provide the opportunity to study data that is independent of investigator and institution bias across time and location.

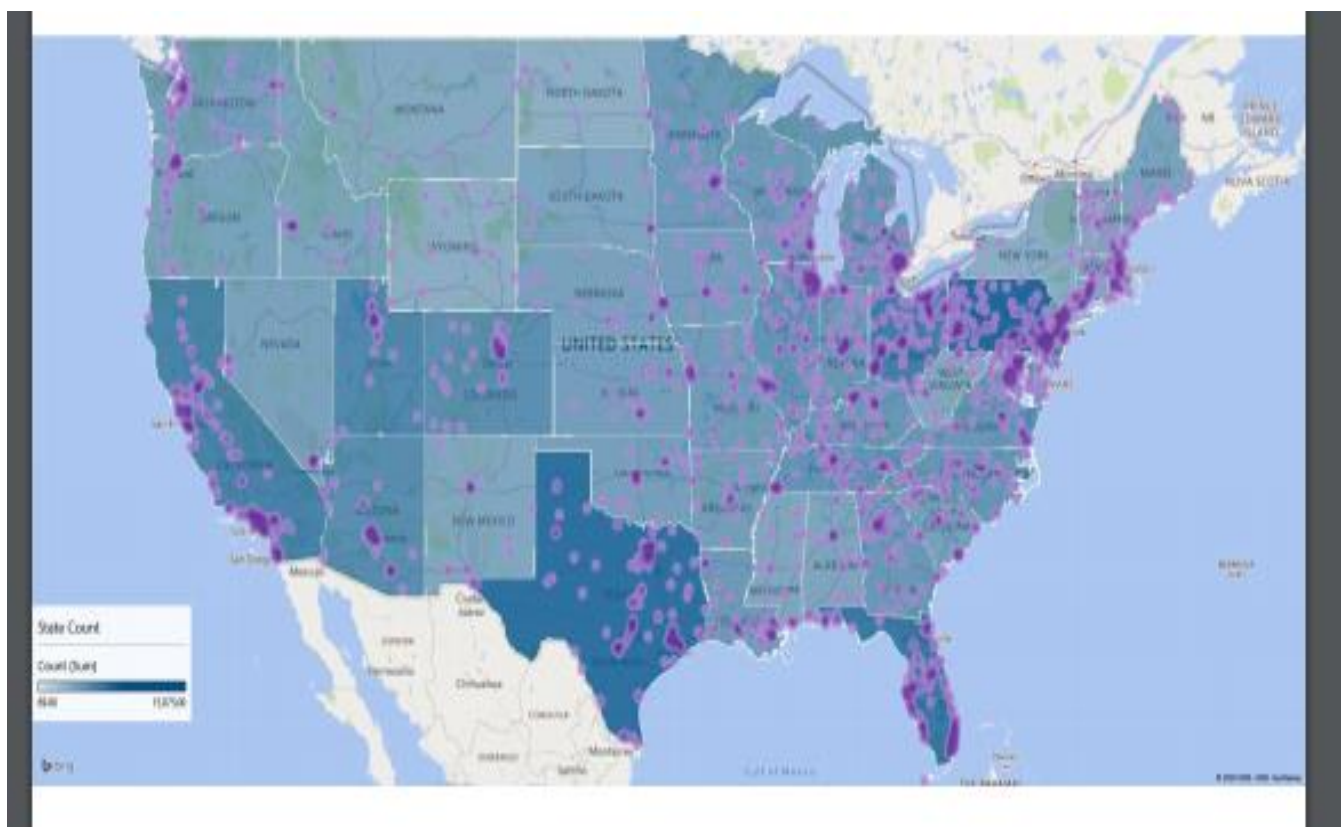
Study Question: What are the bacterial pathogens that cause PJI by location and time in the United States?

Methods: Data from a single independent diagnostic laboratory (CD Diagnostics, Claymont, DE) that performs synovial fluid analysis on a high volume of specimens for the diagnosis of PJI were analyzed to determine concordance with the prevalence of PJI across the United States and to report prevalence of bacterial PJI pathogens across the United States. Extensive systematic error checking was performed on the database for data format and content to ensure high data integrity. This study was determined exempt by UA-COMP IRB and analysis was performed in R.

Results: The specimen distribution in the database (Map 1) was found to be highly concordant with the prevalence of PJI across the United States. The data are accumulating at more than 900 specimens per week. From Jan 2014- Dec 2019 there were 152,908 specimens, 106,075 of which were cultured. 13,947 specimens had positive cultures identifying 346 different bacterial species. The top ten bacterial pathogens in 2019 make up 62.4% of the positive cultures: coagulase negative staph 27.3% (*S epidermidis* 21.7% and *S lugdunensis* 5.6%), coagulase positive staph 19.0% (*S aureus*) streptococcus 14.5% (Nutritional Variant Strep 6.1% - *G adiacens* 6.1% and *A defectiva* 3.5%, *S mitis/oralis* 2.6%, *S agalactiae* 2.3%), *E faecalis* 3.4%, *Pseudomonas aeruginosa* 2.6% and *Corynebacterium striatum* 2.4%. Regional prevalence was compiled for each State and geographic region with a 3 yr rolling average for the change over time.

Discussion: These data document the prevalence of PJI pathogens by location over time allowing providers to understand the pathogens they should expect in the region in which they practice.

Conclusion: These data also establish a foundation for further epidemiological study.



Disclosures

Program Committee

Maja Babic, MD: (This individual reported nothing to disclose); Submitted on: 06/15/2020

Barry Brause, MD: Submitted on: 06/12/2020

Journal of Bone and Joint Infection: Editorial or governing board

Musculoskeletal Infection Society (MSIS): Board or committee member

Laura Certain, MD, PhD: Submitted on: 06/13/2020

Musculoskeletal Infection Society: Board or committee member

Antonia Chen: Submitted on: 04/01/2020

3M: Paid consultant

AAOS: Board or committee member

AJRR: Board or committee member

American Association of Hip and Knee Surgeons: Board or committee member

American Medical Foundation: Paid consultant

Annals of Joint: Editorial or governing board

Avanos: Paid consultant; Research support

bOne: Paid consultant; Stock or stock Options

Clinical Orthopaedics and Related Research: Editorial or governing board

Convatec: Paid consultant

Ethicon: Paid consultant

European Knee Association: Board or committee member

GLG: Paid consultant

Graftworx: Stock or stock Options

Guidepoint: Paid consultant

Healthcare Transformation: Editorial or governing board

Heraeus: Paid consultant

Hyalex: Stock or stock Options

International Congress for Joint Reconstruction: Board or committee member

Irrimax: Paid consultant; Stock or stock Options

Joint Purification Systems: Stock or stock Options

Journal of Arthroplasty: Editorial or governing board

Journal of Bone & Joint Infection: Editorial or governing board

Journal of Bone and Joint Surgery - American: Editorial or governing board

Journal of Orthopaedic Research: Editorial or governing board Knee Surgery, Sports Traumatology, Arthroscopy: Editorial or governing board

Musculoskeletal Infection Society: Board or committee member

Pfizer: Paid consultant

PhagoMed: Paid consultant

Recro: Paid consultant

SLACK Incorporated: Publishing royalties, financial or material support

Sonoran: Stock or stock Options

Stryker: Paid consultant

UpToDate: Publishing royalties, financial or material support

Christopher J Gauland, DPM: Submitted on: 06/16/2020

Austin Medical Ventures: Paid presenter or speaker

Alexander C McLaren: Submitted on: 06/12/2020

Musculoskeletal Infection Society: Board or committee member

Sonoran Biosciences: Stock or stock Options

Andy O. Miller: Submitted on: 06/12/2020

BoneSupport: Paid consultant

Michael J O'Malley: Submitted on: 06/15/2020

Smith & Nephew: Paid consultant

Thompson Surgical: Paid consultant

Thorsten M Seyler: Submitted on: 05/30/2020

American Association of Hip and Knee Surgeons: Board or committee member

Heraeus: Paid consultant

KCI: Research support Lippincott Williams & Wilkins: Publishing royalties, financial or material support

MedBlue Incubator Inc: Research support

Musculoskeletal Infection Society: Board or committee member

Next Science: Research support

Pattern Health: IP royalties

Restor3d: IP royalties

Samumed: Research support

Smith & Nephew: Paid consultant

Total Joint Orthopedics, Inc: IP royalties

Total Joint Orthopedics, Inc.: Paid consultant

Zimmer: Research support

Gina Suh: Submitted on: 06/16/2020

Adaptive Phage Therapeutics (APT): Research support

Marcy Wilkinson, Staff: (This individual reported nothing to disclose); Submitted on: 06/03/2020

Faculty

A.

Hesham Abdelbary: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Alexander Aleem: Submitted on: 06/29/2020

OREF: Research support

Wright Medical Technology, Inc.: Paid consultant

Zimmer: Paid consultant

Orkhan Aliyev: (This individual reported nothing to disclose); Submitted on: 07/08/2020

Jared M Alswang: (This individual reported nothing to disclose); Submitted on: 05/28/2020

Derek Amanatullah: Submitted on: 04/03/2020

AAOS: Board or committee member

DePuy, A Johnson & Johnson Company: Paid consultant

Exactech, Inc: IP royalties; Paid consultant

Journal of Arthroplasty: Editorial or governing board

Journal of Orthopaedic Research: Editorial or governing board

Orthopaedic Research and Education Foundation: Research support

Osteosynthesis and Trauma Care Foundation: Research support

QT Ultrasound: Stock or stock Options

Radial Medical: Stock or stock Options

Recoup Fitness: Stock or stock Options

Reflexion: Research support

Roam Robotics: Research support

Sparta Health Science: Research support

Stryker: Paid consultant; Research support
WebMD: Publishing royalties, financial or material support
Zimmer: Paid consultant; Research support

Qiang An: (This individual reported nothing to disclose); Submitted on: 07/08/2020

Hiba K Anis: (This individual reported nothing to disclose); Submitted on: 06/26/2020

William Arnold: Submitted on: 07/15/2020
AAOS: Board or committee member
Franklin Bioscience, Lannette Pharmaceuticals: Stock or stock Options
Journal of Arthroplasty: Editorial or governing board
Lannete Pharmaceuticals: Employee
Merck: Employee; Stock or stock Options
Norwich Pharmaceuticals: Stock or stock Options
Stryker: Research support
Zimmer: Research support

Asad Ashraf: (This individual reported nothing to disclose); Submitted on: 07/19/2020

Paul S Attar: Submitted on: 06/02/2020
BRIDGE PTS: Other financial or material support
BRIDGE PTS, Inc.: Employee

B.

Maja Babic, MD: (This individual reported nothing to disclose); Submitted on: 06/15/2020

Amy Backal: (This individual reported nothing to disclose); Submitted on: 07/09/2020

Cynthia Barbosa Da Silveira, PhD: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Wael K Barsoum: Submitted on: 06/23/2020
Beyond Limits: Stock or stock Options
Capsico Health: Stock or stock Options
Custom Orthopaedic Solutions: IP royalties; Stock or stock Options
DJO, Inc.: Research support
Editor in Chief- Journal of Hip Surgery: Editorial or governing board
Exactech, Inc: IP royalties
Health XL: Stock or stock Options
NIH: Research support
Orthosensor: Research support
PeerWell: Stock or stock Options
PT Genie: Stock or stock Options
Sight Medical: Stock or stock Options
Stryker: IP royalties; Paid consultant; Paid presenter or speaker; Research support
Thieme: Publishing royalties, financial or material support
Third Frontier: Research support
Zimmer: IP royalties; Research support

Cameron B Barton: (This individual reported nothing to disclose); Submitted on: 05/07/2020

Paul Begeman: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Pedro K. Beredjiklian: Submitted on: 07/10/2020
Cross Current Business Analytics: Stock or stock Options
Dimension Orthotics LLC: Stock or stock Options
Force Therapeutics: Stock or stock Options
Journal of Hand Surgery - American: Editorial or governing board

Matador, Inc: Stock or stock Options
OBERD: Stock or stock Options
Saunders/Mosby-Elsevier: Publishing royalties, financial or material support
Thieme: Publishing royalties, financial or material support
Wright Medical Technology, Inc.: Stock or stock Options

Nicholas Matthew Bernthal: Submitted on: 06/19/2020

Biomet: Paid consultant
Bone Support: Paid consultant
Daiichi Sankyo: Paid consultant
Musculoskeletal Tumor Society: Board or committee member
Onkos: Paid consultant
Orthopaedic Research and Education Foundation: Board or committee member

Mohit Bhandari: Submitted on: 01/22/2020

Acumed, LLC: Research support
Aphria: Research support
Ferring Pharmaceuticals: Research support
Pendopharma: Paid consultant; Research support
Sanofi-Aventis: Paid consultant; Research support

Sarah Bhattacharjee: (This individual reported nothing to disclose); Submitted on: 06/29/2020

Paul Bollyky: (This individual reported nothing to disclose); Submitted on: 06/28/2020

Mathias Bostrom: Submitted on: 07/14/2020

American Austrian Foundation: Board or committee member
Hip Society: Board or committee member
HSS Journal: Editorial or governing board
Ines Mandl Research Foundation: Research support
Journal of Orthopaedic Research: Editorial or governing board
National Institutes of Health (NIAMS & NICHD): Research support
Smith & Nephew: IP royalties; Paid consultant; Research support

Kathleen M Bowers, BS: (This individual reported nothing to disclose); Submitted on: 06/26/2020

Jonathan Boyd: (This individual reported nothing to disclose); Submitted on: 07/13/2020

K. Keely Boyle: (This individual reported nothing to disclose); Submitted on: 06/28/2020

Barry D Brause, MD: Submitted on: 06/12/2020

Journal of Bone and Joint Infection: Editorial or governing board
Musculoskeletal Infection Society (MSIS): Board or committee member

Leigham Breckenridge: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Shane P Bross: (This individual reported nothing to disclose); Submitted on: 06/29/2020

Kimberly M Brothers: (This individual reported nothing to disclose); Submitted on: 06/29/2020

Scot Brown: (This individual reported nothing to disclose); Submitted on: 06/05/2020

Timothy S Brown: Submitted on: 07/13/2020

American Association of Hip and Knee Surgeons: Board or committee member
American Journal of Orthopedics: Editorial or governing board

Jan Brügger, MD: Submitted on: 05/16/2020
AstraZeneca: Paid presenter or speaker

Jessica Burns: (This individual reported nothing to disclose); Submitted on: 04/23/2020

C.

John J Callaghan: Submitted on: 04/24/2020

Cresco Labs: Stock or stock Options

DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant

Flexion Therapeutics: Stock or stock Options

International Hip Society: Board or committee member

Joint Vue: Stock or stock Options

Journal of Arthroplasty: Editorial or governing board

Journal of Arthroplasty (Deputy Editor): Publishing royalties, financial or material support

Knee Society: Board or committee member

Orthopaedic Research and Education Foundation: Board or committee member

Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

John J Callaghan: (This individual reported nothing to disclose); Submitted on: 07/03/2020

Sarah Cantu: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Alex J Cappellini: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Alberto Carli: Submitted on: 07/12/2020

KCI: Paid consultant

Paulo Castaneda: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Laura Certain, MD, PhD: Submitted on: 06/13/2020

Musculoskeletal Infection Society: Board or committee member

Nicolas Cevallos: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Brian Chalmers: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Ameen Chaudry: (This individual reported nothing to disclose); Submitted on: 07/11/2020

James Chen: (This individual reported nothing to disclose); Submitted on: 06/28/2020

Antonia Chen: Submitted on: 04/01/2020

3M: Paid consultant

AAOS: Board or committee member

AJRR: Board or committee member

American Association of Hip and Knee Surgeons: Board or committee member

American Medical Foundation: Paid consultant

Annals of Joint: Editorial or governing board

Avanos: Paid consultant; Research support

bOne: Paid consultant; Stock or stock Options

Clinical Orthopaedics and Related Research: Editorial or governing board

Convatec: Paid consultant

Ethicon: Paid consultant

European Knee Association: Board or committee member

GLG: Paid consultant

Graftworx: Stock or stock Options

Guidepoint: Paid consultant
 Healthcare Transformation: Editorial or governing board
 Heraeus: Paid consultant
 Hyalex: Stock or stock Options
 International Congress for Joint Reconstruction: Board or committee member
 Irrimax: Paid consultant; Stock or stock Options
 Joint Purification Systems: Stock or stock Options
 Journal of Arthroplasty: Editorial or governing board
 Journal of Bone & Joint Infection: Editorial or governing board
 Journal of Bone and Joint Surgery - American: Editorial or governing board
 Journal of Orthopaedic Research: Editorial or governing board Knee Surgery, Sports Traumatology, Arthroscopy:
 Editorial or governing board
 Musculoskeletal Infection Society: Board or committee member
 Pfizer: Paid consultant
 PhagoMed: Paid consultant
 Recro: Paid consultant
 SLACK Incorporated: Publishing royalties, financial or material support
 Sonoran: Stock or stock Options
 Stryker: Paid consultant
 UpToDate: Publishing royalties, financial or material support

Robin Cheng: (This individual reported nothing to disclose); Submitted on: 04/03/2020

Emanuele Chisari: (This individual reported nothing to disclose); Submitted on: 06/12/2020

Yu-fen Chiu: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Jeongeun Cho: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Ahab Chopra: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Madhav Chowdhry: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Matthew Christie: (This individual reported nothing to disclose); Submitted on: 04/03/2020

Kyle H Cichos: (This individual reported nothing to disclose); Submitted on: 07/08/2020

Matthew Ciminero: (This individual reported nothing to disclose); Submitted on: 04/01/2020

Samuel Clarkson: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Jamie Elizabeth Collins, MA: Submitted on: 06/03/2020

Osteoarthritis and Cartilage: Editorial or governing board

Yhan E Colon Iban: (This individual reported nothing to disclose); Submitted on: 06/15/2020

Jessica Colon-Franco: (This individual reported nothing to disclose); Submitted on: 06/26/2020

Herbert Cooper: Submitted on: 07/15/2020

AAOS: Board or committee member

DePuy, A Johnson & Johnson Company: Paid consultant

Joint Purification Systems, Inc.: Paid consultant

Journal of Arthroplasty: Editorial or governing board

Journal of Bone and Joint Surgery - American: Editorial or governing board

KCI: Paid presenter or speaker; Research support

KCI Medical Canada, Inc: Paid consultant
KCI USA, Inc: Paid consultant OnPoint Knee, Inc.: Paid consultant
Smith & Nephew: Research support Zimmer-Biomet: Paid consultant

Michael Cross: Submitted on: 07/06/2020

Bone and Joint Journal 360: Editorial or governing board
DePuy, A Johnson & Johnson Company: Paid consultant
Exactech, Inc: Paid consultant; Research support
Flexion Therapeutics: Paid consultant; Paid presenter or speaker
Imagen: Stock or stock Options
Insight Medical: Stock or stock Options
Intellijoint: Paid consultant; Research support; Stock or stock Options
Journal of Orthopaedics and Traumatology: Editorial or governing board
KCI: Paid consultant; Paid presenter or speaker; Research support
Parvizi Surgical Innovation: Stock or stock Options
Smith & Nephew: Paid consultant
Techniques in Orthopaedics: Editorial or governing board

Daniel Cunningham: (This individual reported nothing to disclose); Submitted on: 04/01/2020

Brian M. Curtin: Submitted on: 05/29/2020

American Association of Hip and Knee Surgeons: Board or committee member
American Joint Replacement Registry Review Commission: Board or committee member
Biomet: Paid consultant
CareStream: Paid consultant
Clinical Orthopaedics and Related Research: Editorial or governing board
DePuy, A Johnson & Johnson Company: Paid presenter or speaker
European Journal of Orthopaedic Surgery and Traumatology: Editorial or governing board
International Congress for Joint Reconstruction: Board or committee member
Johnson & Johnson: Paid consultant
Journal of Arthroplasty: Editorial or governing board
Orthopedics: Editorial or governing board
Springer: Publishing royalties, financial or material support
Stryker: Paid consultant

Fred Cushner: Submitted on: 06/29/2020

Acelity: Paid consultant
American Journal of Orthopedics: Editorial or governing board
canary medical: Stock or stock Options
Elsevier, Smith and Nephew: Publishing royalties, financial or material support
Knee, CORR, Orthopedics: Editorial or governing board
orthalign: Paid consultant; Stock or stock Options
Smith & Nephew: Paid consultant; Paid presenter or speaker
smith and nephew: IP royalties
thieme: Publishing royalties, financial or material support

D.

Joseph D'Alonzo: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Christopher Damsgaard: Submitted on: 07/13/2020

Allergen: Paid consultant
Amgen Co: Paid presenter or speaker
Breg: Research support

Eli Lilly: Paid presenter or speaker
Norvartis: Paid presenter or speaker
Teva: Paid presenter or speaker

Ryan DeAngelis: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Carl A Deirmengian, MD, FAAOS: Submitted on: 07/12/2020

Biomet: Paid consultant
Biostar Ventures: Paid consultant; Stock or stock Options
Domain: Stock or stock Options
Trice: Stock or stock Options
Zimmer: Paid consultant; Paid presenter or speaker; Research support

Gregory John Della Rocca, MD, PhD, FAAOS, FACS: Submitted on: 05/06/2020

AAOS: Board or committee member
American College of Surgeons: Board or committee member
American Orthopaedic Association: Board or committee member
AOTrauma: Board or committee member
Geriatric Orthopaedic Surgery and Rehabilitation: Editorial or governing board
Journal of Orthopaedic Trauma: Editorial or governing board
Mergen: Stock or stock Options
Orthopaedic Trauma Association: Board or committee member
The Orthopaedic Implant Company: Stock or stock Options
Wright Medical Technology, Inc.: IP royalties

Craig J Della Valle, MD, FAAOS: Submitted on: 06/23/2020

American Association of Hip and Knee Surgeons: Board or committee member
Arthritis Foundation: Board or committee member
DePuy, A Johnson & Johnson Company: Paid consultant
Knee Society: Board or committee member
Orthopedics Today: Editorial or governing board
Orthophor and Surgiphor: Stock or stock Options
Parvizi Surgical Innovations: Stock or stock Options
SLACK Incorporated: Editorial or governing board; Publishing royalties, financial or material support
Smith & Nephew: IP royalties; Paid consultant; Research support
Stryker: Research support
Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support
Zimmer: IP royalties; Paid consultant; Research support

Alex J Demers: (This individual reported nothing to disclose); Submitted on: 05/24/2020

Sai K. Devana: (This individual reported nothing to disclose); Submitted on: 06/28/2020

Matthew Dietz: Submitted on: 06/01/2020

American Association of Hip and Knee Surgeons: Board or committee member
Guidepoint Consulting: Paid consultant
Heraeus Medical: Paid consultant
Stryker: Research support
ynotrac/Graftworx: Stock or stock Options

Julian E. Dilley: (This individual reported nothing to disclose); Submitted on: 05/29/2020

Douglas A Dennis, MD, FAAOS: Submitted on: 04/26/2020

Clinical Orthopaedics and Related Research: Editorial or governing board
Corin U.S.A.: Paid consultant; Paid presenter or speaker; Stock or stock Options
DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Paid presenter or speaker
DePuy, A Johnson & Johnson Company, Porter Adventist Hospital: Research support
Joint Vue: Stock or stock Options

Journal of Arthroplasty: Editorial or governing board
Journal of Bone and Joint Surgery - American: Editorial or governing board
Orthopedics Today: Editorial or governing board
Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Matthew Dipane: (This individual reported nothing to disclose); Submitted on: 05/27/2020

Darren D'Mello, BA: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Daniel Driscoll: (This individual reported nothing to disclose); Submitted on: 04/02/2020

Michael Duran: (This individual reported nothing to disclose); Submitted on: 07/21/2020

E.

Nima Eftekhary: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Charles A Engh III, BS, MS: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Ahmed Emara, MD: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Orry Erez: Submitted on: 06/25/2020

AAOS: Board or committee member

American Association of Hip and Knee Surgeons: Board or committee member

New York State Society of Orthopedic Surgeons: Board or committee member

Premia Spine: Stock or stock Options

F.

Christopher Fang: (This individual reported nothing to disclose); Submitted on: 06/26/2020

Kevin X. Farley: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Keith A. Fehring: Submitted on: 05/29/2020

American Association of Hip and Knee Surgeons: Board or committee member

DePuy, A Johnson & Johnson Company: IP royalties; Other financial or material support; Paid consultant; Paid presenter or speaker; Research support

Knee Society: Board or committee member

Andrew Figoni: (This individual reported nothing to disclose); Submitted on: 06/23/2020

Salvador A Forte: (This individual reported nothing to disclose); Submitted on: 07/13/2020

David Freccero: Submitted on: 06/29/2020

American Association of Hip and Knee Surgeons: Board or committee member

Conformis: Research support

DePuy, A Johnson & Johnson Company: Research support

Freddie H Fu: Submitted on: 06/30/2020 American Orthopaedic Society for Sports Medicine: Board or committee member

Asian Journal of Arthroscopy: Editorial or governing board

Current Reviews in Musculoskeletal Journal: Editorial or governing board

Elsevier/Operative Techniques in Orthopaedics: Editorial or governing board

FORMOSAN Journal of Musculoskeletal Disorders: Editorial or governing board

International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine: Board or committee member

Isokinetics and Exercise Science: Editorial or governing board

Journal of Dance Medicine & Science: Editorial or governing board

Journal of Exercise Science & Fitness: Editorial or governing board

Journal of Orthopaedic Surgery (Asia/Pacific Ortho Association): Editorial or governing board
Journal of Orthopaedic Surgery and Research (Chinese Speaking Orthopaedic Society): Editorial or governing board
Knee Surgery, Sports Traumatology, Arthroscopy: Editorial or governing board
Open Access Journal of Sports Medicine: Editorial or governing board
OrthoEvidence: Editorial or governing board
Orthopedics Today: Editorial or governing board
Saunders/Mosby-Elsevier: Editorial or governing board
SLACK Incorporated: Publishing royalties, financial or material support
Smith & Nephew: Unpaid consultant
Sports Exercise and Injury: Editorial or governing board
Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support
World Endoscopy Doctors Association: Board or committee member

G.

Brigitta Gahl: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Scott A Galey: (This individual reported nothing to disclose); Submitted on: 06/28/2020

Christopher Gardner: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Grant Garrigues: Submitted on: 07/21/2020

Additive Orthopaedics: Paid consultant

American Shoulder and Elbow Surgeons: Board or committee member

Arthrex, Inc: Other financial or material support

Arthroscopy Association of North America: Board or committee member

CultivateMD: Stock or stock Options

DJ Orthopaedics: IP royalties; Other financial or material support; Paid consultant; Paid presenter or speaker

Genesys: Stock or stock Options

Journal of Shoulder and Elbow Surgery: Editorial or governing board

Mitek: Paid consultant

Patient IQ: Stock or stock Options

ROM 3: Stock or stock Options

SouthTech: Other financial or material support

Techniques in Orthopaedics: Editorial or governing board

Tornier: IP royalties; Paid consultant; Paid presenter or speaker

John Gaughan: (This individual reported nothing to disclose); Submitted on: 06/18/2020

Christopher J Gauland, DPM: Submitted on: 06/16/2020

Austin Medical Ventures: Paid presenter or speaker

Jason Gay: (This individual reported nothing to disclose); Submitted on: 09/07/2019

Elie S Ghanem: (This individual reported nothing to disclose); Submitted on: 07/05/2020

Benjamin Giertych: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Julie E Glener: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Stuart Goodman: Submitted on: 06/13/2020

Accelalox: Stock or stock Options; Unpaid consultant

ARCO: Board or committee member

Arquos: Stock or stock Options

Bioengineering: Editorial or governing board

Biomaterials: Editorial or governing board; Publishing royalties, financial or material support

Bone and Joint Research: Editorial or governing board

Clinical Orthopaedics and Related Research: Editorial or governing board
Hyalex: IP royalties; Stock or stock Options
J Arthroplasty: Editorial or governing board
J Biomed Mater Res: Editorial or governing board
Journal of Orthopaedic Research: Editorial or governing board; Publishing royalties, financial or material support
Journal of Orthopaedic Translation: Editorial or governing board
Merck Manual: Publishing royalties, financial or material support
Open Orthopaedics Journal: Editorial or governing board
Orthopedics: Editorial or governing board
PLOS ONE: Editorial or governing board
Pluristem: Paid consultant
Regenerative Engineering and Translational Medicine: Editorial or governing board
Wishbone Medical: Paid consultant

Karan Goswami: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Nitin Goyal, MD: (This individual reported nothing to disclose); Submitted on: 07/17/2020

Danielle Greig: (This individual reported nothing to disclose); Submitted on: 06/12/2020

Preston W. Grieco: (This individual reported nothing to disclose); Submitted on: 04/30/2020

William Griffin: Submitted on: 04/01/2020

AAOS: Board or committee member
American Association of Hip and Knee Surgeons: Board or committee member
DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Paid presenter or speaker; Research support
Hip Society: Board or committee member
Hyalex: Stock or stock Options
Knee Society: Board or committee member
Zimmer: Research support

Hannah Groff: (This individual reported nothing to disclose); Submitted on: 01/28/2020

Matthew J Grosso: Submitted on: 05/03/2020

American Association of Hip and Knee Surgeons: Board or committee member

Angelica Guardia: (This individual reported nothing to disclose); Submitted on: 07/12/2020

George Guild: Submitted on: 04/30/2020

American Association of Hip and Knee Surgeons: Board or committee member
KCI: Research support
Smith & Nephew: Paid consultant; Research support
Total Joint Orthopaedics: Paid consultant; Stock or stock Options

D'Andrew Gursay: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Michael J. Gutman: (This individual reported nothing to disclose); Submitted on: 06/13/2020

H.

Brian R Hamlin: Submitted on: 06/29/2020

AAOS: Board or committee member
Bodycad: IP royalties; Paid consultant; Stock or stock Options
Journal of Arthroplasty: Editorial or governing board
Knee: Editorial or governing board
Smith & Nephew: Paid consultant

Erik N Hansen: (This individual reported nothing to disclose); Submitted on: 07/02/2020

Michael Henry(This individual reported nothing to disclose); Submitted on: 07/22/2020

Tyler Henry, BS: (This individual reported nothing to disclose); Submitted on: 06/13/2020

Eric Heintz: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Tanja Hermann: (This individual reported nothing to disclose); Submitted on: 06/08/2020

Christopher J Hernandez: (This individual reported nothing to disclose); Submitted on: 07/10/2020

Matthew Hess: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Angela Hewlett: Submitted on: 06/20/2020

Mapp Biopharmaceutical Inc. (research on Ebola therapeutic agent); Research support

Musculoskeletal Infection Society: Board or committee member

Springer: Publishing royalties, financial or material support

Carlos A Higuera Rueda, MD, FAAOS: Submitted on: 07/01/2020

American Association of Hip and Knee Surgeons: Board or committee member

American Journal of Orthopedics: Editorial or governing board

CD Diagnostics: Research support

Cymedica: Research support

Ferring Pharmaceuticals: Research support

Journal of Arthroplasty: Editorial or governing board

Journal of Hip Surgery: Editorial or governing board

Journal of Knee Surgery: Editorial or governing board

KCI: Paid consultant; Paid presenter or speaker; Research support

Lyfstone: Research support

Mid-American Orthopaedic Association: Board or committee member

Musculoskeletal Infection Society: Board or committee member

OREF: Research support

Orthofix, Inc.: Research support

PSI: Stock or stock Options

Stryker: Research support

Zimmer: Research support

Derek L Hill: Submitted on: 04/01/2020

AZ Solutions, LLC: Stock or stock Options

Zoe W. Hinton: (This individual reported nothing to disclose); Submitted on: 05/25/2020

Jason Hsu: Submitted on: 06/05/2020

American Shoulder and Elbow Surgeons: Board or committee member

DJ Orthopaedics: IP royalties; Paid consultant

Journal of Bone and Joint Surgery - American: Editorial or governing board

Miami Device Solutions: Unpaid consultant

James Huddleston: Submitted on: 06/01/2020

AAOS: Board or committee member

American Association of Hip and Knee Surgeons: Board or committee member

Apple: Research support

Biomet: Paid consultant; Research support

Corin U.S.A.: Paid consultant; Paid presenter or speaker; Research support; Stock or stock Options Exactech, Inc: IP royalties; Paid consultant; Paid presenter or speaker

Journal of Arthroplasty: Editorial or governing board

Knee Society: Board or committee member

Porosteon: Stock or stock Options

Wolters Kluwer: IP royalties Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Yale CORE: Unpaid consultant

Zimmer: Paid consultant; Paid presenter or speaker; Research support

Alessandra Hunt, DDS, MSc, PhD: (This individual reported nothing to disclose); Submitted on: 06/02/2020

I.

Lionel Ivashkiv: Submitted on: 07/01/2020

Eli Lilly: Unpaid consultant

J.

Jaclyn M Jankowski: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Landry Jarvis, MD: (This individual reported nothing to disclose); Submitted on: 06/22/2020

Gang Ji: (This individual reported nothing to disclose); Submitted on: 07/13/2020

William A. Jiranek: Submitted on: 06/15/2020

American Association of Hip and Knee Surgeons: Board or committee member

Biomech Holdings LLC: Stock or stock Options

DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant

Hip Society: Board or committee member

Eric Jordan: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Minseon Ju: (This individual reported nothing to disclose); Submitted on: 10/04/2019

K.

Kevin Kang: Submitted on: 01/22/2020

Brooklyn Orthopaedic Society: Board or committee member

Milan Kapadia: (This individual reported nothing to disclose); Submitted on: 06/29/2020

Joseph Karam: (This individual reported nothing to disclose); Submitted on: 07/07/2020

Jay Keener: Submitted on: 06/16/2020

American Shoulder and Elbow Surgeons: Board or committee member

Journal of Shoulder and Elbow Surgery: Editorial or governing board

National Institutes of Health (NIAMS & NICHD): Research support

Shoulder Innovations: IP royalties

Wright Medical Technology, Inc.: IP royalties

David M Keller: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Benjamin V Kelley: (This individual reported nothing to disclose); Submitted on: 06/10/2020

Alec S Kellish: (This individual reported nothing to disclose); Submitted on: 06/16/2020

Daniel O Kendoff: Submitted on: 04/15/2020

Aesculap/B.Braun: Paid presenter or speaker

Link Orthopaedics: Paid presenter or speaker

Zimmer: Paid presenter or speaker

Yehuda E Kerbel: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Vishal Khatri: Submitted on: 06/06/2019
DePuy, A Johnson & Johnson Company: Paid consultant

Michael M Kheir: (This individual reported nothing to disclose); Submitted on: 06/08/2020

Shinsuke Kihara: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Beau J. Kildow: (This individual reported nothing to disclose); Submitted on: 05/30/2020

Raymond Y Kim: Submitted on: 06/06/2020
Ceramtec: Paid presenter or speaker
Convatec: Paid presenter or speaker
DJ Orthopaedics: IP royalties; Paid consultant
ICJR: Board or committee member
Innomed: IP royalties

Raymond Y Kim: (This individual reported nothing to disclose); Submitted on: 06/30/2020

Gregory J Kirchner: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Brian A Klatt: Submitted on: 06/30/2020
AAOS: Board or committee member
AAOSAAHKS Abstract Review Committee: Board or committee member
American Association of Hip and Knee Surgeons: Board or committee member
Clinical Orthopaedics and Related Research: Editorial or governing board
Journal of Arthroplasty: Editorial or governing board
Journal of the American Academy of Orthopaedic Surgeons: Editorial or governing board
MSIS: Board or committee member
SLACK Incorporated: Publishing royalties, financial or material support

Alison K Klika: (This individual reported nothing to disclose); Submitted on: 06/01/2020

John Koch: (This individual reported nothing to disclose); Submitted on: 07/12/2020

David A. Kolin: (This individual reported nothing to disclose); Submitted on: 06/22/2020

Joseph Koressel: (This individual reported nothing to disclose); Submitted on: 06/30/2020

Jonathan Michael Kosco, MD: (This individual reported nothing to disclose); Submitted on: 07/04/2020

Chad Krueger: Submitted on: 06/29/2020
American Association of Hip and Knee Surgeons: Board or committee member
Journal of Arthroplasty: Editorial or governing board

L.
David C. Landy: Submitted on: 06/22/2020
American Journal of Sports Medicine: Editorial or governing board

Maxwell K Langfitt: (This individual reported nothing to disclose); Submitted on: 06/07/2020

Allison Lastinger: Submitted on: 07/13/2020
Pfizer: Stock or stock Options

Gwo-Chin Lee: Submitted on: 05/31/2020
AAOS: Board or committee member
Clinical Orthopaedics and Related Research: Editorial or governing board
Corin U.S.A.: Paid consultant
Ferring Pharmaceuticals: Research support
Heron Therapeutics: Paid consultant
Journal of Arthroplasty: Editorial or governing board
Journal of Bone and Joint Surgery: Editorial or governing board
KCI: Research support Orthopedics: Editorial or governing board
SLACK Incorporated: Editorial or governing board
Smith & Nephew: Research support
Stryker: Paid consultant
United Orthopedics: Research support

Michael J. Lee: Submitted on: 06/30/2020
DePuy, A Johnson & Johnson Company: Paid consultant
Stryker: Paid consultant

Ashley E Levack: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Brett R Levine: Submitted on: 05/20/2020
AAOS: Board or committee member
American Association of Hip and Knee Surgeons: Board or committee member
Exactech, Inc: Paid consultant
Human kinetics: Editorial or governing board [Link](#)
Orthopaedics: Paid consultant
Merete: Paid consultant
SLACK Incorporated: Editorial or governing board
Zimmer: Research support

Alexander M Lieber: (This individual reported nothing to disclose); Submitted on: 06/30/2020

Steven A Lietman: (This individual reported nothing to disclose); Submitted on: 07/03/2020

Andreas Limacher: (This individual reported nothing to disclose); Submitted on: 06/09/2020

Frank A Liporace: Submitted on: 07/15/2020
AO: Unpaid consultant
Biomet: IP royalties; Paid consultant; Paid presenter or speaker; Research support
Synthes: Paid consultant; Paid presenter or speaker
Wright Medical Technology, Inc.: IP royalties; Research support

Christina Y Liu: (This individual reported nothing to disclose); Submitted on: 06/08/2020

Matthew Lokant: (This individual reported nothing to disclose); Submitted on: 07/13/2020

David Lowenberg: Submitted on: 06/21/2020
Foundation for Orthopaedic Trauma: Board or committee member
Nuvasive: Paid consultant
Osteosynthesis and Trauma Care Foundation: Board or committee member

Kevin F. Lutsky: Submitted on: 06/16/2020
American Society for Surgery of the Hand: Board or committee member

Tianyi David Luo, MD: (This individual reported nothing to disclose); Submitted on: 04/01/2020

Hue Luu: Submitted on: 06/05/2020
American Orthopaedic Association: Board or committee member
Stryker: Paid consultant

M.

Dongzhu Ma: (This individual reported nothing to disclose); Submitted on: 06/29/2020

Ankur Makani: Submitted on: 07/13/2020
Corvus: Stock or stock Options
Mylan: Employee

William Maloney: Submitted on: 07/13/2020
AAOS: Board or committee member
Flexion Therapeutics, Inc: Stock or stock Options
Flexion Therapeutics, Inc.: Paid consultant
Knee Society: Board or committee member
Stryker: IP royalties; Paid consultant
TJO: Stock or stock Options
Western Orthopedic Association: Board or committee member
Zimmer: IP royalties

Mitchell G Maltenfort: (This individual reported nothing to disclose); Submitted on: 06/23/2020

Zeinab Mamouei: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Robert Manasherob: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Jonathan B Mandell: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Angelo Mannino: (This individual reported nothing to disclose); Submitted on: 05/24/2020

Jorge Manrique: Submitted on: 06/15/2020
Colombian Journal of Orthopedics and Traumatology: Editorial or governing board
International Consensus Meeting on Periprosthetic Joint Infection: Editorial or governing board
Parvizi Surgical Innovations: Stock or stock Options

David C Markel: Submitted on: 06/09/2020
Arboretum Ventures: Stock or stock Options
Ascension Providence Hospital: Research support
Clinical Orthopaedics and Related Research: Editorial or governing board
HOPCo: Stock or stock Options
Journal of Arthroplasty: Editorial or governing board
Journal of Bone and Joint Surgery - American: Editorial or governing board
Michigan Arthroplasty Registry Collaborative Quality Initiative: Board or committee member
Michigan Orthopaedic Society, aahks, mid america ortho assoc: Board or committee member
OREF: Research support
Osteoarthritis and Cartilage: Editorial or governing board
Stryker: Paid consultant; Paid presenter or speaker; Research support
US Veteran Administration: Research support

Rakesh Mashru: (This individual reported nothing to disclose); Submitted on: 06/18/2020

Jonas L. Matzon: (This individual reported nothing to disclose); Submitted on: 06/19/2020

Anita Maurer: (This individual reported nothing to disclose); Submitted on: 06/14/2020

Erik Mayer: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Richard M. McEntee: (This individual reported nothing to disclose); Submitted on: 05/26/2020

Gerald McGwin Jr, MS, PhD: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Alexander C McLaren: Submitted on: 06/12/2020
Musculoskeletal Infection Society: Board or committee member
Sonoran Biosciences: Stock or stock Options

Alexander S. McLawhorn: Submitted on: 05/31/2020
HSS Journal: Editorial or governing board

Edward J. McPherson: Submitted on: 05/27/2020
Austin Medical Ventures: Paid consultant; Paid presenter or speaker
Biomet: IP royalties; Paid consultant; Paid presenter or speaker
BoneSupport AB: Paid presenter or speaker
Reconstructive Review: Editorial or governing board

Ariana Meltzer-Bruhn: (This individual reported nothing to disclose); Submitted on: 07/14/2020

R Michael Meneghini, MD, FAAOS: Submitted on: 06/22/2020
American Association of Hip and Knee Surgeons: Board or committee member
DJ Orthopaedics: IP royalties; Paid consultant; Research support
Emovi: Stock or stock Options
International Congress for Joint Reconstruction: Board or committee member
Journal of Arthroplasty: Editorial or governing board
KCI: Paid consultant
Kinamed: Paid consultant
Knee Society: Board or committee member
Orthopedics Today: Editorial or governing board
Osteoremedies: IP royalties; Paid consultant
Surgical Care Affiliates (SCA): Paid consultant

Luke Menken: (This individual reported nothing to disclose); Submitted on: 06/19/2020

Lawrence Miller: (This individual reported nothing to disclose); Submitted on: 06/23/2020

Andy O. Miller: Submitted on: 06/12/2020
BoneSupport: Paid consultant

Rebecca I Minorini: (This individual reported nothing to disclose); Submitted on: 05/13/2020

Jon E Minter, DO, FAAOS: Submitted on: 06/15/2020
DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Paid presenter or speaker
Merck: Stock or stock options
Microgen: Paid presenter or speaker; Stock or stock Options
OsteoRemedies: Paid consultant; Paid presenter or speaker
Reconstructive Review: Editorial or governing board
Stryker: IP royalties; Paid consultant; Paid presenter or speaker; Stock or stock Options

Phillip Mitchell, MD: (This individual reported nothing to disclose); submitted on: 06/29/2020

Peter N Mittwede: Submitted on: 06/27/2020

AAOS: Board or committee member

Orthopaedic Trauma Association: Board or committee member

Ruben Monarrez: (This individual reported nothing to disclose); Submitted on: 05/26/2020

Michael A Mont: Submitted on: 05/27/2020

AAOS: Board or committee member

American Association of Hip and Knee Surgeons: Board or committee member

Cymedica: Paid consultant

Flexion Therapeutics: Paid consultant

Johnson & Johnson: Paid consultant; Research support

Journal of Arthroplasty: Editorial or governing board

Journal of Knee Surgery: Editorial or governing board Knee Society: Board or committee member Medicus Works

LLC: Publishing royalties, financial or material support

National Institutes of Health (NIAMS & NICHD): Research support

Orthopedics: Editorial or governing board

Peerwell: Stock or stock Options

Pfizer: Paid consultant

Stryker: IP royalties; Paid consultant; Research support

Surgical Techniques International: Editorial or governing board

Tissue Gene: Paid consultant

TissueGene: Research support Up-to Date: Publishing royalties, financial or material support

USMI: Stock or stock Options

Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Jake Mooney: (This individual reported nothing to disclose); Submitted on: 06/29/2020

Rex Moore: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Thomas E Moran: (This individual reported nothing to disclose); Submitted on: 05/24/2020

Vincent M Moretti: (This individual reported nothing to disclose); Submitted on: 07/09/2020

Kevin Morton: (This individual reported nothing to disclose); Submitted on: 06/05/2020

James E Murphy: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Thomas Myers: Submitted on: 04/22/2020

Journal of Arthroplasty: Editorial or governing board

N.

Denis Nam: Submitted on: 06/01/2020

KCI: Paid consultant; Research support Stryker: Paid consultant Zimmer: Research support

Surena Namdari: Submitted on: 06/05/2020

Aevumed: IP royalties; Stock or stock Options

Arthrex, Inc: Research support

Bone & Joint 360: Editorial or governing board

DePuy, A Johnson & Johnson Company: Research support

DJ Orthopaedics: IP royalties; Paid consultant; Paid presenter or speaker; Research support

Flexion Therapeutics: Paid consultant

Force Therapeutics: Stock or stock Options

Integra: Research support

MD Live: Stock or stock Options

MD Valuate: Stock or stock Options

Miami device solutions: IP royalties; Paid consultant; Paid presenter or speaker
Orthophor: Stock or stock Options
Parvizi Surgical Innovations: Stock or stock Options
Philadelphia Orthopaedic Society: Board or committee member
RubiconMD: Stock or stock Options
Saunders/Mosby-Elsevier: Publishing royalties, financial or material support
SLACK Incorporated: Publishing royalties, financial or material support
Synthes: Paid consultant
Tangen: Stock or stock Options
Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support
Wright Medical Technology, Inc.: Research support
Zimmer: Research support

Mitchell Ng: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Thema Nicholson: (This individual reported nothing to disclose); Submitted on: 06/15/2020

Michael Niemann: (This individual reported nothing to disclose); Submitted on: 06/17/2020

Lucas E Nikkel: Submitted on: 06/28/2020
DePuy, A Johnson & Johnson Company: Paid consultant
Total Joint Orthopedics: Paid consultant

Kian Niknam: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Sita Nirupama Nishtala: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Hubert Noetzli: Submitted on: 06/08/2020
Medid, Switzerland: Stock or stock Options; Unpaid consultant
Zimmer: Paid consultant; Paid presenter or speaker

Erica L Noland: (This individual reported nothing to disclose); Submitted on: 05/04/2020

O.

Christopher Odom: (This individual reported nothing to disclose); Submitted on: 07/19/2020

Ali Oliashirazi: Submitted on: 07/15/2020
DePuy, A Johnson & Johnson Company: Paid consultant; Paid presenter or speaker; Research support
Medtronic: Paid consultant
Zimmer: Paid consultant

Michael J O'Malley: Submitted on: 06/15/2020
Smith & Nephew: Paid consultant
Thompson Surgical: Paid consultant

Jesse E Otero: Submitted on: 05/28/2020
American Association of Hip and Knee Surgeons: Board or committee member
DePuy, A Johnson & Johnson Company: Paid consultant; Research support

Derek Overstreet: Submitted on: 07/14/2020
Sonoran Biosciences: Employee; Stock or stock Options

Cynthia Overstreet: Submitted on: 07/14/2020
Sonoran Biosciences: Employee; Stock or stock Options

P.

Tejbir S Pannu: (This individual reported nothing to disclose); Submitted on: 06/03/2020

Joseph S Park: Submitted on: 07/10/2020

American Orthopaedic Foot and Ankle Society: Board or committee member

DePuy, A Johnson & Johnson Company: Paid presenter or speaker; Research support

Integra LifeSciences: IP royalties

LifeNet Health: Paid consultant; Paid presenter or speaker

Paragon28: Research support

Stryker: Research support

Javad Parvizi: Submitted on: 06/22/2020

Acumed, LLC: Stock or stock Options

Alphaeon: Stock or stock Options

Ceribell: Stock or stock Options

Corentec: IP royalties; Paid consultant; Stock or stock Options

Datatrace: Publishing royalties, financial or material support

Elsevier: Publishing royalties, financial or material support

Ethicon: Paid consultant

Flexion: Paid consultant

Heraeus: Paid consultant

Hip Innovation Technology: Stock or stock Options

Intellijoint: Stock or stock Options

Jaypee Publishers: Publishing royalties, financial or material support

Joint Purification Systems: Stock or stock Options

Jointstem: Paid consultant

KCI / 3M (Acelity): Paid consultant

MDValuate: Stock or stock Options

MicroGenDx: Paid consultant; Stock or stock Options

Molecular Surface Technologies: Stock or stock Options

Nanooxygenic: Stock or stock Options

Parvizi Surgical Innovations and Subsidiaries: Stock or stock Options

Peptilogics: Paid consultant

PRN-Veterinary: Stock or stock Options

SLACK Incorporated: Publishing royalties, financial or material support

Sonata: Stock or stock Options

Tenor: Paid consultant

Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Zimmer Biomet: Paid consultant

Nicolas Pascual-Leone: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Shaun P. Patel: Submitted on: 06/09/2020

American Association of Hip and Knee Surgeons: Board or committee member

Journal of Arthroplasty: Editorial or governing board

Journal of Orthopaedic Experience & Innovation: Editorial or governing board

Orthobullets: Editorial or governing board

Jeffrey Pearson: Submitted on: 06/30/2020

Johnson & Johnson: Stock or stock Options

Stryker: Stock or stock Options

Christopher Earl Pelt, MD, FAAOS: Submitted on: 06/15/2020

AAOS: Board or committee member

American Association of Hip and Knee Surgeons: Board or committee member

Joint Development, LLC: Stock or stock Options KCI: Paid consultant; Paid presenter or speaker
Smith & Nephew: Paid consultant; Paid presenter or speaker
TJO (Total Joint Orthopedics): IP royalties; Paid consultant; Paid presenter or speaker
Zimmer Biomet: Paid consultant; Paid presenter or speaker; Research support

Julia Penatzer: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Elizabeth Pensler: Submitted on: 06/01/2020
AZ Solutions: Stock or stock Options

Brian Perez: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Kelly Pillinger: (This individual reported nothing to disclose); Submitted on: 07/07/2020

Cody Pinger: Submitted on: 04/01/2020
AZ Solutions: Paid consultant

Nicolas S Piuzzi: Submitted on: 06/11/2020
ISCT: Board or committee member
Journal of Hip Surgery: Editorial or governing board
Journal of Knee Surgery: Editorial or governing board
Orthopaedic Research Society: Board or committee member
RegenLab: Research support
Zimmer: Research support

Johannes F Plate: (This individual reported nothing to disclose); Submitted on: 05/29/2020

Ajay Premkumar: (This individual reported nothing to disclose); Submitted on: 06/15/2020

Hernan Prieto, MD: Submitted on: 06/20/2020
Florida Orthopedic Society annual meeting program committee: Board or committee member

Nicole Prince: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Taylor M Pust: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Q.

Katelyn Quartuccio: (This individual reported nothing to disclose); Submitted on: 06/01/2020

R.

Emily Ren: (This individual reported nothing to disclose); Submitted on: 04/01/2020

WEIPING REN: (This individual reported nothing to disclose); Submitted on: 07/11/2020

Joshua M Reside: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Santiago Restrepo: (This individual reported nothing to disclose); Submitted on: 07/16/2020

Ana Ribau: (This individual reported nothing to disclose); Submitted on: 06/24/2020

Eric Ricchetti: Submitted on: 04/14/2020
AAOS: Board or committee member
American Board of Orthopaedic Surgery, Inc.: Board or committee member
American Shoulder and Elbow Surgeons: Board or committee member
DJ Orthopaedics: IP royalties; Paid consultant; Paid presenter or speaker
Journal of Shoulder and Elbow Surgery: Editorial or governing board

Anthony R Richardson: Submitted on: 04/18/2017
Pfizer: Stock or stock Options

Aldo M Riesgo: Submitted on: 06/30/2020
Stryker: Paid consultant
Zimmer: Paid consultant

Levi L Riley: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Lorenz Risch: (This individual reported nothing to disclose); Submitted on: 10/04/2019

Raquel Roberts: (This individual reported nothing to disclose); Submitted on: 05/29/2020

Martin W Roche: Submitted on: 06/06/2020
CMO - Orthosensor: Employee
mako - stryker: Paid consultant
mako- stryker, Orthosensor: IP royalties mako-stryker, Orthosensor: Paid presenter or speaker makosurgical-stryker:
Research support Orthosensor: Stock or stock Options
Smith & Nephew: Research support

Felix Rohrer: (This individual reported nothing to disclose); Submitted on: 02/27/2020

Ravi Rudraraju, MD: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Sean P Ryan: (This individual reported nothing to disclose); Submitted on: 05/30/2020

S.

Anna Cristina Samia, PhD: (This individual reported nothing to disclose); Submitted on: 07/23/2020

Nemandra A Sandiford: (This individual reported nothing to disclose); Submitted on: 04/18/2020

Simon Saner: (This individual reported nothing to disclose); Submitted on: 06/05/2020

Adam Sassoon: Submitted on: 06/01/2020
American Association of Hip and Knee Surgeons: Board or committee member
Biocomposites Inc.: Paid consultant
Orthalign: Paid consultant
Smith & Nephew: Paid consultant

Pierre-Emmanuel Schwab: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Edward M. Schwarz, PhD: Submitted on: 07/12/2020
Arthritis Research & Therapy: Editorial or governing board; Publishing royalties, financial or material support
Asahi KASEI Pharma Corporation: Paid consultant; Paid presenter or speaker
bausch & Lomb: Paid consultant
DePuy, A Johnson & Johnson Company: Paid consultant; Research support
Eli Lilly: Research support
Journal of Bone and Joint Infection: Editorial or governing board
Journal of Orthopaedic Research: Editorial or governing board; Publishing royalties, financial or material support
MedImmune: Paid consultant
Musculoskeletal Transplant Foundation: Paid consultant
Orthopaedic Research Society: Board or committee member
Parvizi Surgical Innovations, LLC: Unpaid consultant
Regeneron: Paid consultant
Telephus: Research support
Telephus Biosciences: Other financial or material support; Stock or stock Options

Ran Schwarzkopf: Submitted on: 04/06/2020

AAOS: Board or committee member

American Association of Hip and Knee Surgeons: Board or committee member

Arthroplasty Today: Editorial or governing board

Gauss surgical: Stock or stock Options

Intellijoint: Paid consultant; Stock or stock Options

Journal of Arthroplasty: Editorial or governing board

Smith & Nephew: IP royalties; Paid consultant; Research support

Giles Scuderi: Submitted on: 04/28/2020

Acelity: Paid consultant

Biomet: IP royalties; Paid consultant; Paid presenter or speaker

Convatec: Paid presenter or speaker

Force Therapeutics: Stock or stock Options

Medtronic: Paid consultant; Paid presenter or speaker

Operation Walk USA: Board or committee member

Pacira: Paid consultant; Paid presenter or speaker; Research support

SpringerElsevierThiemeWorld Scientific: Publishing royalties, financial or material support

Zimmer: IP royalties; Paid consultant; Paid presenter or speaker

Peter K. Sculco: Submitted on: 06/04/2020

DePuy, A Johnson & Johnson Company: Paid consultant; Paid presenter or speaker

EOS Imaging: Paid consultant; Paid presenter or speaker

Intellijoint Surgical: Paid consultant; Paid presenter or speaker

Intellijoint Surgical: Research support

Lima Corporate: Paid consultant

Jessica L. Seidelman: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Troy Sekimura: (This individual reported nothing to disclose); Submitted on: 05/26/2020

Thorsten M Seyler: Submitted on: 05/30/2020

American Association of Hip and Knee Surgeons: Board or committee member

Heraeus: Paid consultant

KCI: Research support Lippincott Williams & Wilkins: Publishing royalties, financial or material support

MedBlue Incubator Inc: Research support

Musculoskeletal Infection Society: Board or committee member

Next Science: Research support

Pattern Health: IP royalties

Restor3d: IP royalties

Samumed: Research support

Smith & Nephew: Paid consultant

Total Joint Orthopedics, Inc: IP royalties

Total Joint Orthopedics, Inc.: Paid consultant

Zimmer: Research support

Taylor L Shackleford: (This individual reported nothing to disclose); Submitted on: 06/09/2020

Neel Shah: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Alisina Shahi: (This individual reported nothing to disclose); Submitted on: 07/11/2020

Lewis L. Shi: Submitted on: 06/02/2020

Arthrex, Inc: Paid presenter or speaker

DePuy, A Johnson & Johnson Company: Paid consultant; Paid presenter or speaker

Journal of Shoulder and Elbow Arthroplasty: Editorial or governing board

Jack Shilling: (This individual reported nothing to disclose); Submitted on: 07/14/2020

Noam Shohat: (This individual reported nothing to disclose); Submitted on: 07/07/2020

Ahmed Siddiqi: Submitted on: 07/12/2020

AZ Solutions, LLC: Unpaid consultant

ROM Tech: Stock or stock Options

Zimmer: Paid consultant

Herrick J Siegel: Submitted on: 04/03/2020

Aesculap/B.Braun: Paid consultant; Paid presenter or speaker

American Registry of Pathology: Publishing royalties, financial or material support

Biomet: IP royalties; Paid consultant; Paid presenter or speaker

Corin: Paid consultant Corin U.S.A.: Paid presenter or speaker

Exactech, Inc: Paid consultant; Paid presenter or speaker

Journal of Foot and Ankle Surgery: Editorial or governing board

Musculoskeletal Tumor Society: Board or committee member

Onkos Surgical: Paid consultant

Orthopedics Today: Editorial or governing board

Signature Orthopaedics: Unpaid consultant

Smith & Nephew: Paid consultant; Paid presenter or speaker

Ronald Silverman: Submitted on: 06/29/2020

3M: Employee; Stock or stock Options

Vishavpreet Singh: (This individual reported nothing to disclose); Submitted on: 06/29/2020

Stephen C Sizer: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Eric L Smith: Submitted on: 04/29/2020

AAOS: Board or committee member

American Orthopaedic Association: Board or committee member

Conformis: Paid consultant; Research support

DePuy, A Johnson & Johnson Company: Paid consultant; Research support

Eric L Smith: (This individual reported nothing to disclose); Submitted on: 07/05/2020

Upneet Sokhi: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Alex Soriano: Submitted on: 02/19/2020

Angelini: Paid presenter or speaker

European Bone and Joint Infection Society: Board or committee member

Haereus: Paid presenter or speaker

Menarini: Paid presenter or speaker Merck: Paid presenter or speaker

Pfizer: Paid consultant; Paid presenter or speaker

Shionogi: Paid presenter or speaker

Ricardo Sousa: Submitted on: 06/27/2020

European Bone and Joint Infection Society: Board or committee member

Portuguese Orthopedics and Traumatology Society: Board or committee member

Clay A Spitler: Submitted on: 04/15/2020

AAOS: Board or committee member

AO Trauma: Paid presenter or speaker

DePuy, A Johnson & Johnson Company: Paid consultant

Journal of Bone and Joint Surgery - American: Editorial or governing board

KCI: Paid consultant

Orthopaedic Trauma Association: Board or committee member

ROM 3 Rehab LLC: Stock or stock Options

Bryan D. Springer: Submitted on: 04/24/2020

AJRR: Board or committee member

American Association of Hip and Knee Surgeons: Board or committee member

Arthroplasty Today: Editorial or governing board

Ceramtec: Paid presenter or speaker

Convatec: Paid consultant

ICJR: Board or committee member

Joint purifications systems.: Other financial or material support

Journal of Arthroplasty: Editorial or governing board

Knee Society: Board or committee member

osteoremedies: Paid consultant

Stryker: IP royalties; Paid consultant

Alexandra Stavrakis: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Matthew Stein: (This individual reported nothing to disclose); Submitted on: 06/30/2020

Jessica Stern: (This individual reported nothing to disclose); Submitted on: 06/01/2020

Joshua T Stripling: (This individual reported nothing to disclose); Submitted on: 07/18/2020

Gina Suh: Submitted on: 06/16/2020

Adaptive Phage Therapeutics (APT): Research support

Kamolsak Sukhonthamarn: (This individual reported nothing to disclose); Submitted on: 06/22/2020

Anne C. Sullivan: Submitted on: 04/25/2020

AAOS: Board or committee member

Aaos practice prep package: Editorial or governing board

Biocomposites, Ltd.: Research support

Hannah Szapary: (This individual reported nothing to disclose); Submitted on: 04/01/2020

T.

Masashi Taguchi: (This individual reported nothing to disclose); Submitted on: 07/06/2020

Timothy L Tan: (This individual reported nothing to disclose); Submitted on: 06/09/2020

Aaron J. Tande, MD: Submitted on: 07/27/2020

Musculoskeletal Infection Society: Board or committee member

Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Nathan P Thomas: (This individual reported nothing to disclose); Submitted on: 05/31/2020

Lance R Thurlow: (This individual reported nothing to disclose); Submitted on: 06/29/2020

Nicholas Ting: (This individual reported nothing to disclose); Submitted on: 06/06/2020

Shane C Tipton: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Rishi Trikha: (This individual reported nothing to disclose); Submitted on: 04/13/2020

Kathleen Turajane: (This individual reported nothing to disclose); Submitted on: 01/22/2020

Ibrahim Tuncay, MD: Submitted on: 07/15/2020

Zimmer: Unpaid consultant

U.

Kenneth L Urish: Submitted on: 06/29/2020

AAOS: Board or committee member

ASTM: Board or committee member

Peptilogics: Paid consultant

Smith & Nephew: Paid consultant; Research support

V.

Rahul Vaidya: Submitted on: 06/30/2020

Journal of Orthopaedics and Traumatology: Editorial or governing board

Orthopaedic Trauma Association: Board or committee member

Pfizer: Research support

Rushabh M Vakharia: (This individual reported nothing to disclose); Submitted on: 06/19/2020

Nathan H Varady: (This individual reported nothing to disclose); Submitted on: 06/24/2020

Jesus M Villa: (This individual reported nothing to disclose); Submitted on: 06/03/2020

Anabelle Visperas: (This individual reported nothing to disclose); Submitted on: 06/01/2020

W.

Kevin Wall: (This individual reported nothing to disclose); Submitted on: 07/08/2020

Sara Wallace: (This individual reported nothing to disclose); Submitted on: 06/09/2020

David L Wang: Submitted on: 10/03/2019

Catalyst Orthoscience: Stock or stock Options

David L Wang: (This individual reported nothing to disclose); Submitted on: 07/02/2020

Jared A Warren: (This individual reported nothing to disclose); Submitted on: 06/01/2020

David Wellman: Submitted on: 06/17/2020

DePuy, A Johnson & Johnson Company: Paid presenter or speaker

HSS Journal: Editorial or governing board

Imagen: Stock or stock Options

OrthoDevelopment: Paid consultant

Zachary Wells: Submitted on: 07/13/2020

Johnson & Johnson: Stock or stock Options

Pfizer: Employee; Stock or stock Options

Zimmer: Stock or stock Options

Marcelle H Wilkinson: (This individual reported nothing to disclose); Submitted on: 06/03/2020

Seneca Williams: (This individual reported nothing to disclose); Submitted on: 07/13/2020

Alan E Wilson: (This individual reported nothing to disclose); Submitted on: 06/23/2020

Jacob M. Wilson: (This individual reported nothing to disclose); Submitted on: 04/02/2020

Edward Arnold Woods III, MBA: (This individual reported nothing to disclose); Submitted on: 05/09/2020

Marjan Wouthuyzen-Bakker: Submitted on: 02/19/2020

Zimmer: Unpaid consultant

Christine J Wu: (This individual reported nothing to disclose); Submitted on: 06/02/2020

Shannon Wu: (This individual reported nothing to disclose); Submitted on: 06/28/2020

X.

Yunwei Xia: (This individual reported nothing to disclose); Submitted on: 07/17/2020

Y.

Steven J Yacovelli: (This individual reported nothing to disclose); Submitted on: 04/02/2020

Hunter B Yancey: (This individual reported nothing to disclose); Submitted on: 10/05/2019

Xu Yang: (This individual reported nothing to disclose); Submitted on: 07/02/2020

Michael Yayac: (This individual reported nothing to disclose); Submitted on: 04/06/2020

Michael R Yeaman: Submitted on: 06/15/2020

Alexion: Paid presenter or speaker

Genentech-Roche: Paid presenter or speaker; Unpaid consultant

Metacin, Inc.: IP royalties; Stock or stock Options

NovaDigm Therapeutics, Inc.: IP royalties; Stock or stock Options

Fatih Yildiz: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Richard S Yoon: Submitted on: 07/13/2020

Arthrex, Inc: Paid consultant

Biomet: Research support

BuiltLean: Unpaid consultant

Coventus: Research support

DePuy, A Johnson & Johnson Company: Paid consultant

LIfEeNet Health: Paid consultant

Orthobullets: Paid consultant

ORTHOXEL: Paid consultant

Springer: Publishing royalties, financial or material support

Surgical Care Affiliates (SCA): Paid presenter or speaker

Synthes: Paid consultant; Research support

Taithera Inc.: Stock or stock Options

Use-Lab: Paid consultant

Wright Medical Technology, Inc.: Paid consultant; Research support

Z.

Mary Ziemba-Davis: (This individual reported nothing to disclose); Submitted on: 06/15/2020

Benjamin Zmistowski: (This individual reported nothing to disclose); Submitted on: 07/12/2020

Andrey Zuskov, MD: (This individual reported nothing to disclose); Submitted on: 06/01/2020