Musculoskeletal Infection Society

31st Annual Open Scientific Meeting

MUSCULOSKELETAL INFECTION SOCIETY

August 6-7, 2021

FORT LAUDERDALE, FLORIDA

IN PERSON AND VIRTUAL MEETING

Please join us!

32nd Annual Open Scientific Meeting

of the

Musculoskeletal Infection Society

MUSCULOSKELETAL INFECTION SOCIETY

PITTSBURGH

PENNSYLVANIA

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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 utility of articulating spacers, antibiotic loaded cement, and intraosseous vancomycin in the management of musculoskeletal infections;

- Discuss challenging clinical cases of musculoskeletal infection, including diagnostics and management strategies.

- Evaluate the utility of various irrigation solutions and local antibiotic therapy.

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 31st Annual Open Scientific Virtual Meeting, for a maximum of ***10.75 AMA PRA Category 1 Credits™***. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Course Director and Musculoskeletal Infection Society President

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Special Thanks

To the Members who answered the call to serve when additional help was needed with Abstract and Presentation Reviews

Andy Miller Michael Henry Antonia Chen Alberto Carli Carlos Higuera-Rueda

Brian Klatt Aaron Tande Angela Hewlett Ted Louie F. Johannes Plate

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Musculoskeletal Infection Society
31st Annual Open Scientific Meeting
August 6-7, 2021
Fort Lauderdale, FL and Virtually

Agenda

Friday, August 6, 2021
Caribben Ballroom

7:00am	**Registration Opens**
7:00–8:00am	**Breakfast** *On the Ocean Terrace* **Visit Exhibitors and e-Posters**
8:00-8:14am	**Welcome, Disclosures** Presentation of the George C. Cierny, III, M.D. Memorial Award Angela Hewlett, MD, MSIS President
Abstract Session I:	**Epidemiology and Prevention** Moderators: Dr. Abinash Virk, Dr. Alberto Carli
8:15-8:21am	Dilute Povidone-Iodine Irrigation Reduces the Rate of Periprosthetic Joint Infection Following Hip and Knee Arthroplasty: An Analysis of 31,331 Cases ***Graham Goh**, Noam Shohat*
8:22-8:28am	History of COVID-19 Was Not Associated with Length of Stay or In-Hospital Complications After Elective Lower Extremity Joint Replacement *Anna Jungwirth-Wienberger, Friedrich Boettner, Milan Kapadia, Alioune Diane, Yu-Fen Chiu, Stephen Lyman, Mark Fontana, **Andy Miller***
8:29-8:35am	Racial disparities in the risks of septic and aseptic revision total knee replacements *Anne Bass, Huong Do, Bella Mehta, Stephen Lyman, Serene Mirza, Michael Parks, Mark Figgie, Lisa Mandl, **Susan Goodman***
8:36-8:42am	Malnutrition Predicts Failure of Two-Stage Exchange for Chronic Periprosthetic Joint Infection *Michael Valenzuela, Taylor Rowe, Susan Odum, Thomas Fehring, Jesse Otero, **Cody Green***

8:43-8:53am	**Discussion**
8:54-9:00am	When Should We Change Gloves? Surgical Gloves Have High Contamination Rates *Emanuele Chisari, P Maxwell Courtney, Javad Parvizi, Chad Krueger,* ***Leanne Ludwick***
9:01-9:07am	Aspirin thromboprophylaxis following primary total knee arthroplasty is associated with a lower rate of early prosthetic joint infection compared with other chemoprophylactic agents ***Vinay Aggarwal****, Utkarsh Anil, Noah Kirschner, Greg Teo, Katherine Lygrisse, Ran Schwarzkopf, William Long, Chelsea Sicat*
9:08-9:14am	Extended Oral Antibiotic Prophylaxis Does Not Alter Rates of Antimicrobial Resistance in Organisms Causing Periprosthetic Joint Infection Following Primary and Aseptic Revision Total Joint Arthroplasty *Poorani Sekar, Kunatum Prasidthrathsint, Nicholas Bedard,* ***Christopher Carender***
9:15-9:21am	Extended Oral Antibiotics Increase Bacterial Resistance in Patients who Fail Two-Stage Exchange for Periprosthetic Joint Infection *Mick Kelly, Brenna Blackburn, Jeremy Gililland,* ***Laura Certain***
9:22-9:32am	**Discussion**
9:33-9:45am	**Refreshment Break** **Visit Exhibitors and ePosters**
SYMPOSIUM #1:	**Updates in the Management of Complicated Bone and Joint Infections** Moderators: Dr. Andy Miller, Dr. Kevin Perry
9:45-10:05am	**Updates in the use of articulating spacers** Curtis Hartman MD, Orthopaedic Surgeon University of Nebraska, Omaha, NE
10:06-10:26am	**Antibiotic loaded beads and cement spacers** Christina O'Connor PharmD, BCPS Mayo Clinic, Rochester, MN
10:27-10:47am	**Intraosseous vancomycin** Bryan Springer MD, Orthopaedic Surgeon OrthoCarolina, Charlotte, NC
10:48-11:08am	**Discussion**

Abstract Session II: Basic Science
Moderators: Dr. Yale Fillingham, Dr. Laura Certain

11:09-11:15am Contact with Blood Does not Affect Bactericidal Properties of Povidone-Iodine
Emanuele Chisari, Chad Krueger, Javad Parvizi, ***Ilan Small***

11:16-11:22am PhotothermAA gel decreases biofilm burden in a rabbit model of Periprosthetic Joint Infection
Daniel Santana, Minseon Ju, Nathalie Milbrandt, Yu Hsin Tsai, Nicolas Piuzzi, Alison Klika, Anna Cristina Samia, Carlos Higuera-Rueda, ***Anabelle Visperas***

11:23-11:29am Immune Response to Persistent Staphyloccocus aureus Periprostethic Joint Infection (PJI) in a Mouse Tibial Implant Model
Yunwei Xia, Branden Sosa, Nirupama Nishtala, Tania Pannellini, Mathias Bostrom, Alberto Carli, Xu Yang, Lionel Ivashkiv, ***Upneet Sokhi***

11:30-11:36am Novel Antibody Disrupts Biofilm Bacteria in a Mouse Model of Spinal Implant Infection
Zachary Burke, Benjamin Kelley, Zeinab Mamouei, Micah Ralston, Amr Turkmani, Alexandra Stavrakis, Nicholas Bernthal, ***Christopher Hart***

11:37-11:47am **Discussion**

11:48-11:54am Bacteriophage is More Effective in Treating MRSA Biofilm on Plasma Spray Titanium Surface Compared to Vancomycin
Hesham Abdelbary, ***Mariam Taha***

11:55-12:01pm Rapid synovial fluid-induced aggregation of Staphylococcus aureus occurs across clinical isolates and is mechanistically independent of biofilm formation
Peter Burback , Paul Stoodley ,, Kenneth Urish , Mostafa Eltobgy, ***Amelia Staats***

112:02-12:08pm Cannabidiol Failed to Inhibit Staphylococcus aureus Infection in an in vivo Mouse Model of Spinal Implant Infection
Christopher Hart, Micah Ralston, Amr Turkmani, Michael Arnold, Michael Le, Nicholas Bernthal, ***Zeinab Mamouei***

12:09-12:15pm Halicin: a novel antibacterial agent active on Staphylococcus aureus biofilms
Stefanie Simpson, Christopher Collier, Roman Natoli, Mizuho Kittaka, Edward Greenfield, ***Shota Higashihira***

12:16-12:26pm **Discussion**

12:27-1:00pm **Lunch**
Box Lunch, seating available on the Ocean Terrace
Visit Exhibitors and ePosters

SYMPOSIUM # 2: **Challenging Musculoskeletal Infection Cases**
Panelists: Dr. Sandy Nelson, Dr. Brian Klatt, Dr. Steve Schmitt, Dr. Samir Mehta

1:00-1:10pm	**Case #1**: presented by	Poorani Sekar MD, Infectious Disease University of Iowa, Iowa City, IA
1:11-1:26pm	**Discussion**	
1:27-1:37pm	**Case #2**: presented by	Michael Henry MD, Infectious Disease Hospital for Special Surgery, New York, NY
1:38-1:53pm	**Discussion**	
1:54-2:04pm	**Case #3**: presented by	Laura Damioli MD, Infectious Disease University of Colorado, Denver, CO
2:05-2:20pm	**Discussion**	
2:21-2:31pm	**Break** **Visit Exhibitors and ePosters**	

Abstract Session III: **Diagnostics**
Moderators: Dr. Arvind Nana, Dr. Nicolas Cortes-Penfield

2:32-2:38pm	Sequencing microbial cell-free DNA found in blood plasma enhances current pathogen identification for prosthetic joint infections. ***Adriana Echeverria**, Alberto Carli, Mark Figgie, Thomas Bauer, Barry Brause, Michael Henry, Andy Miller, Michael Cross, Laura Donlin*
2:39-2:45pm	Diagnostic Utility of Next Generation Sequencing in PJI ***Karan Goswami**, Javad Parvizi*
2:46-2:52pm	EBJIS Definition for Periprosthetic Joint Infection: Questionable Accuracy ***Emanuele Chisari**, Leanne Ludwick, Noam Shohat, Javad Parvizi*
2:53-2:59pm	Isothermal Microcalorimetry Improves Accuracy and Time to Diagnosis of Fracture Related Infection ***Kyle Cichos**, Clay Spitler, Jonathan Quade, Michael Johnson, Joseph Johnson, Elie Ghanem*
3:00-3:10pm	**Discussion**
3:11-3:17pm	Application of New Consensus Definition Identifies High Numbers of Fracture Related Infections with Negative Cultures. *Kaitlyn Weinert-Stein Julia Slater, Henry Sagi, Margaret Powers-Fletcher,* ***Federico Palacio***

3:18-3:24pm	Joint age, presence of a sinus tract, and revision arthroplasties influence the microbiology of periprosthetic joint infections ***Don Geno Tai** , Robin Patel, Matthew Abdel, Elie Berbari, Aaron Tande*
3:25-3:31pm	Isothermal Microcalorimetry Improves Time to Diagnosis of PJI ***Kyle Cichos**, Elie Ghanem*
3:32-3:38pm	The immune response to bacterial periprosthetic joint infection is heterogenous within the periprosthetic space and is not dependent on PJI chronicity or culture positivity *Sita Nirupama Nishtala, Upneet Sokhi, Tania Pannellini, Miguel Otero, Lionel Ivashkiv, Mathias Bostrom, **Alberto Carli***
3:39-3:49pm	**Discussion**

SYMPOSIUM # 3	**Top Musculoskeletal Infection Papers of 2020-2021**
3:50-4:05pm	Tom Fehring MD, Orthopaedic Surgeon OrthoCarolina, Charlotte, NC
4:06-4:21pm	Aaron Tande MD, Infectious Disease Mayo Clinic, Rochester, MN
4:22-4:37pm	**Discussion**
4:37pm	**Adjourn** **Visit Exhibitors and ePosters**
6:00pm	**Join us for the President's Reception on the Dunes Terrace** Cocktails and 'Havana Coast' Buffet Dinner Dress: Resort Casual

<u>Saturday, August 7, 2021</u>

7:00-7:45am	**MSIS Business Meeting** (MSIS Members only)
7:00-8:00am	**Breakfast** *On the Ocean Terrace* **Visit Exhibitors and ePosters**

Abstract Session IV: Clinical Management

Moderators: Dr. Antonia Chen, Dr. Julie Reznicek

8:00-8:06am Timing of Antibiotic Initiation in the Treatment of Hip and Knee Septic Arthritis
Nathan Varady, Vineet Desai, Adam Olsen, Katiri Wagner, Antonia Chen, ***Jared Alswang***

8:07-8:13am Antibiotic-Loaded Calcium Sulfate Beads Do Not Improve Outcomes After Debridement, Antibiotics, and Implant Retention (DAIR): A Matched Case-Control Study
William Xiang, Chris Jones, Ioannis Gkiatas, Allina Nocon, Nicolas Selemon, Alberto Carli, Peter Sculco, ***David Tarity***

8:14-8:20am Debridement With Antibiotics And Implant Retention: Does Chronicity of Symptoms Matter?
Allina Nocon, Ioannis Gkiatas, Christopher Jones, Alberto Carli, Peter Sculco, ***David Tarity***

8:21-8:27am Systemic Sepsis Secondary to Acute Periprosthetic Joint Infection: Incidence, Risk Factors and Outcomes of Treatment
Noam Shohat, Matthew Sherman, Sydney Streicher, Javad Parvizi, ***Leanne Ludwick***

8:28-8:38am **Discussion**

8:39-8:45am Are septic-indicated distal femoral replacements more likely to require reoperation and revision than aseptic-indicated DFRs?
Christopher Rothfusz*, Ahmed Emara, Alison Klika, Viktor Krebs, Robert Molloy, Carlos Higuera, Nicolas Piuzzi*

8:46-8:52am Positive Cultures in Aseptic Revision Arthroplasty: Are They Truly Contaminants?
Graham Goh*, Samuel Clarkson, Javad Parvizi*

8:53-8:59am Acute Kidney Injury Following Resection and Antibiotic-Loaded Spacer Insertion for Periprosthetic Joint Infection
Graham Goh, ***Terence Thomas****, Conor Drakeley, Ilan Small, Javad Parvizi*

9:00-9:06am Fungal and Mycobacterial Cultures Should Not be Routinely Obtained for Diagnostic Work-Up of Patients with Suspected Periprosthetic Joint Infection
Don Geno Tai*, Nancy Wengenack, Robin Patel, Elie Berbari , Matthew Abdel, Aaron Tande*

9:07-9:17am **Discussion**

9:18-9:30am **Break**
Visit Exhibitors and ePosters

SYMPOSIUM #4: Irrigation Solutions and Local Antibiotic Therapy
Moderators: Dr. Doug Osmon, Dr. Carlos Higuera

9:30-9:50am **Irrigation solutions: Separating science from witchcraft**
Elie Ghanem MD**,** Orthpaedic Surgeon
University of Alabama, Birmingham, AL

The use of the vancomycin powder for perioperative infection prevention: What is the evidence?

9:51-10:06am -**Pro**: Aldo Riesgo MD, Orthopaedic Surgeon
Cleveland Clinic, Weston, FL
10:07-10:22am -**Con**: Thorsten Seyler, MD, Orthopaedic Surgeon
Duke University, Durham NC
10:23-10:43am **Discussion**

10:44-10:54am **CORR Journal Presentation**
10:55-11:05am **JBJI Journal Presentation**

11:05-11:25am **Introduction of Incoming President: Brian Klatt, MD**
Angela Hewlett, MD
Presentation of Awards
Jon T. Mader Award; Jeanette Wilkins Award; e-Poster Award
Closing Remarks; *Angela Hewlett MD*

11:25am **Adjourn**

2021 MSIS ePosters

Monitor 1

21-AEP-880 Characteristics of occult infection with non-union repair in patients without clinical or laboratory signs of infection.
Nihar Shah, Matthew Frederickson, Ramsey S Sabbagh, Evan Dowell, Henry Sagi, Federico Palacio

21-AEP-878 Risk Factors and Characteristics of Recalcitrant Osteomyelitis Following Appropriate Initial Surgical and Antibiotic Treatment
Nihar Shah, Arun Kanhere, John Bonamer, Matthew Doyle, Henry Sagi, Federico Palacio

21-AEP-876 How does the definition of treatment success affect outcomes following One-Stage and Two-Stage revision surgery for Periprosthetic Joint Infection? A Systematic Review and Meta-Analysis
Eytan Debbi, Tyler Khilnani, Yu-Fen Chiu, Stephen Lyman, Ioannis Gkiatas, Alberto Carli

21-AEP-871 Are Routine Intra-operative Cultures Necessary During Revision Shoulder Arthroplasty?
Benjamin Zmistowski, Justin Rabinowitz, Vincent Nguyen, Alexander Aleem

21-AEP-864 Survivorship of Culture Negative Debridement Antibiotics and Implant Retention (DAIR) at 2-Years is Better than Culture Positive DAIR Results
Kyle Alpaugh, Ioannis Gkiatas, T. Tarity, Allina Nocon, William Xiang, Thomas Sculco, Peter Sculco, Michael Cross

21-AEP-863 Patients with non-Staphylococcal prosthetic joint infections who underwent Debridement Antibiotics and Implant retention (DAIR) and received chronic antibiotic suppression (CAS) were non-significantly less likely to have treatment failure compared to those who did not receive CAS
Poorani Sekar, Rajeshwari Nair, Brice Beck, Bruce Alexander, Kelly Miell, Aaron Tande, Kimberly Dukes, Julia Friberg, Marin Schweizer

21-AEP-849 Alpha-Defensin Does Not Provide Additional Benefit over Leukocyte Esterase in the Diagnosis Of Periprosthetic Joint Infection
Emanuele Chisari, Noam Shohat, Steven Yacovelli, Karan Goswami, Yajnesh Vedanaparti, Javad Parvizi

21-AEP-848 Next-generation Sequencing is Superior to PCR and Culture for Staphylococcus aureus Screening
Emanuele Chisari, Leanne Ludwick, Karan Goswami, Javad Parvizi

21-AEP-841 Repeated 2-stage arthroplasty to treat a failed 2-stage revision for periprosthetic hip or knee infection: A tertiary center experience
Tejbir Pannu, Jesus Villa, Ardalan Sayan, Carlos Higuera, Aldo Riesgo

21-AEP-838 Higher Risk of Acute Kidney Injury in Two-Stage versus One-Stage Revision for Periprosthetic Joint Infection: A Randomized Prospective Trial
Michael Valenzuela, Susan Odum, Bryan Springer, Thomas Fehring, Jesse Otero

21-AEP-803 Function Evaluation of Spherocentric Total Elbows
Gerhard Maale, Nicole Kennard, Aniruth Srinivasaraghavan, Arianna Mixon

21-AEP-800 Topical vancomycin and tobramycin powder for infection prophylaxis in orthopaedic trauma surgery: Economically justifiable?
Gregory Kirchner, Matthew Garner, Nathan Smith, Raymond Kim, Shawn Hines

21-AEP-787 Preoperative Risk Factors for Polymicrobial Infection Following Open Fracture
Madeline Lyons, Madeline Tiee, Joseph Cohen, Hobie Summers, Ashley Levack, Garin Hecht Summers

Monitor 2

21-AEP-879 Locked Intramedullary Nail Is Effective as a Static Spacer in Periprosthetic Joint Infection Following TKA
Luke Menken, Filippo Romanelli, Jaclyn Jankowski, Frank Liporace, Richard Yoon

21-AEP-877 Utility of Magnetic Resonance Imaging in Predicting Failure of DAIR (debridement, antibiotics, and implant retention) for Treatment of Periprosthetic Joint Infection
Alberto Carli, Milan Kapadia, Alissa Burge, Eric Bogner, Peter Sculco

21-AEP-869 Do Pre-Reimplantation ESR/CRP Cut offs Guide Decision Making in Prosthetic Joint Infection? Are We Flying Blind?
Nick Johnson, Taylor Rowe , Michael Valenzuela , Gregory Scarola , Thomas Fehring

21-AEP-856 Oxidized Zirconium vs Cobalt Chrome for Primary Total Knee Arthroplasty: No Difference in Infection Rates
Anirudh Gowd, Edward Beck, Samuel Rosas, Tianyi Luo, John Matthews, Johannes Plate

21-AEP-842 Metal-on-Polyethylene Implants Associated with Higher Risk of PJI versus Ceramic-on-Polyethylene
Emanuele Chisari, Christian Ong, Noam Shohat, Javad Parvizi, Chad Krueger

21-AEP-839 Excellent outcome of oral antibiotics for selected patients with bone and joint infection: real-world experience from implementing OVIVA
Jacey Hilbers, Amanda Lang, Mason Halouska, Zachary VanRoy, Angela Hewlett, Nicolas Cortes-Penfield

21-AEP-821 Comparison of One Stage versus Two Stage Revisions for Infected Total Knees
Gerhard Maale, Aniruth Srinivasaraghavan, Nicole Kennard, Arianna Mixon

21-AEP-818 Prevalence of Fungal Pathogens in Periprosthetic Joint Infections
Paulo Castaneda, Varun Sharma, Carl Deirmengian, Alex McLaren

21-AEP-816 Short versus Long Duration of Intravenous Antibiotics in Prosthetic Joint Infections: Systematic Review and Meta-Analysis
Nour Bouji, Sijin Wen, Matthew Dietz

21-AEP-813 Non-aspirin thromboprophylaxis is not associated with early prosthetic joint infection in total hip arthroplasty
Vinay Aggarwal, Utkarsh Anil, Noah Kirschner, Greg Teo, Katherine Lygrisse, Ran Schwarzkopf, William Long, Chelsea Sicat

21-AEP-811 Comparative Outcomes and Surgical Timing for Operative Fragility Hip Fracture Patients During the COVID-19 Pandemic
Antonia Chen, Katherine Rowe, Kiryung Kim, Nathan Varady, Marilyn Heng, Arvind von Keudell, Michael Weaver, Ayesha Abdeen, Edward Rodriguez

21-AEP-793 Autofluorescence Digital Imaging for Diagnosing Chronic Wound Infections: Preliminary Case Series
James Stiehl

21-AEP-786 The Fate of Periprosthetic Joint Infection with Corynebacterium Striatum: A Rare but Catastrophic Causative Organism
Tejbir Pannu, Jesus Villa, Matan Ozery, Nicolas Piuzzi, Carlos Higuera, Aldo Riesgo, Alison Klika

Monitor 3

21-AEP-890 *Novel Activated Zinc Solution More Efficacious Against Pseudomonas aeruginosa and MRSA Biofilm Relative to Dilute Chlorhexidine and Povidone Iodine*
Derek Hill, Elizabeth Pensler, Andre Castiaux, Paul Attar, Ahmed Siddiqi

21-AEP-884 Trend Towards Reduced Early Bacterial Burden With Silicon Nitride vs. Titanium Implants in an in vivo Mouse Model of Periprosthetic Joint Infection
Christopher Hart, Danielle Greig, Zeinab Mamouei, Alan Li, Jeremiah Taylor, chiro Nishimura, Nicholas Bernthal

21-AEP-874 Improving the Intraoperative Assessment of Biofilm in Prosthetic Joint Infection
Daniel Santana, Anabelle Visperas, Alison Klika, Carlos Higuera, Nicolas Piuzzi

21-AEP-867 Candida albicans Enhances the Growth and Colonization of Staphylococcus aureus in a Murine Model of Polymicrobial Implant Infection
Zeinab Mamouei, Christopher Hart, Alan Li, Jeremiah Taylor, Amr Turkmani, Micah Ralston, Nicholas Bernthal

21-AEP-865 Revisiting synovial WBC and PMN% thresholds to determine the outcome of reimplantation in two-stage revision
Tejbir Pannu, Jesus Villa, Aldo Riesgo, Carlos Higuera

21-AEP-853 Surgical Helmets Harbor Common Pathogens that Can Contaminate the Surgical Field
Emanuele Chisari, Duncan Van Nest, Chad Krueger, Javad Parvizi

21-AEP-846 The First-Year Experience of a Regional Referral Center for Periprosthetic Joint Infections
Murillo Adrados, Michael Valenzuela, Gregory Scarola, Thomas Fehring, Jesse Otero

21-AEP-845 Bacterial Tropism affects the Success of DAIR for the Treatment of Periprosthetic Joint Infections? A Systematic Review and Metanalysis
Emanuele Chisari, Leanne Ludwick, Jasmine Wang, Edward Schwarz, Javad Parvizi

21-AEP-832 Delayed Culture Results after Revision Delays Time to Antimicrobial Treatment
Samuel Clarkson, Emanuele Chisari, Duncan Van Nest, Javad Parvizi

21-AEP-830 Multidrug Resistance in PJI Before and After H1N1 Pandemic
Samuel Clarkson, Emanuele Chisari, Leanne Ludwick, Duncan Van Nest, Javad Parvizi

21-AEP-828 Can Next-Generation Sequencing Predict Treatment Failure for Periprosthetic Joint Infection?
Samuel Clarkson, Karan Goswami, Javad Parvizi

21-AEP-825 Treatment of Antibiotic Resistant and Tolerant Persister and Phoenix Variants in Staphylococcus aureus and Pseudomonas aeruginosa Biofilms
Kelly Moore, Anthony Li, Craig Delury, Phillip Laycock, Sean Aiken , Paul Stoodley

21-AEP-795 Culture Negative PJI: Signs & Biomarkers to Guide Diagnosis
Leanne Ludwick, Emanuele Chisari, Kira Smith, Syona Satwah, Javad Parvizi

21-AEP-791 Synovial fluid-induced aggregation of Staphylococcus aureus inhibits neutrophil production of reactive oxygen species (ROS)
Amelia Staats, Paul Stoodley, Peter Burback

Monitor 4

21-AEP-866 D-Dimer is a Sensitive Marker for Acute Periprosthetic Joint Infection
Ayden Case, Lefko Charalambous, Trevor Bowman, Ian Duensing, Edward Hendershot, Jessica Seidelman, Thorsten Seyler, William Jiranek

21-AEP-851 Molecular Carriers for Local Delivery of Drugs without Systemic Elution of the Drug
Gerhard Maale, Nicole Kennard, Aniruth Srinivasaraghavan, Arianna Mixon

21-AEP-844 PJI Could be Result of Damage to Gut Epithelial Barrier
Emanuele Chisari, Karan Goswami, Javad Parvizi

21-AEP-843 Biofilm Eradication: Whatâ€™s New in Biofilm Disruption Strategies for Prosthetic Joint Infection
Anabelle Visperas, Daniel Santana, Alison Klika, Carlos Higuera-Rueda, Nicolas Piuzzi

21-AEP-840 Killing of a Multispecies Biofilm Using a Gram-Negative and Gram-Positive Targeted Antibiotic
Kelly Moore, Anthony Li , Craig Delury , Phillip Laycock, Sean Aiken , Paul Stoodley

21-AEP-837 Methicillin Resistant Staphylococcus aureus is not Always Resistant to Cefazolin
Alex Cappellini, Kimberly Brothers, Kenneth Urish

21-AEP-833 The Burden of Obesity is Greater in Septic Revision Arthroplasty Versus Aseptic Revision Arthroplasty
Cody Green, Taylor Rowe, Michael Valenzuela, Susan Odum, Thomas Fehring

21-AEP-826 Do Extended Oral Antibiotic Prophylaxis Reduce the Incidence of Periprosthetic Joint Infections After Aseptic Total Hip or Knee Arthroplasty Revisions?
Jesus Villa, Tejbir Pannu, William Braaksma, Carlos Higuera, Aldo Riesgo, Alison Klika

21-AEP-823 Multidirectional Instability Following Primary Total Knees Associated with Metal Allergies
Gerhard Maale, Aniruth Srinivasaraghavan, Nicole Kennard, Arianna Mixon

21-AEP-815 Improved Complication Rates Following Total Hip and Knee Arthroplasty in Patients with Treated Hepatitis C
Kenneth Schmidt, Rebecca Chun

21-AEP-814 Improved Outcomes with Inpatient Antibiotic Administration in Recreational Intravenous Drug Users with Orthopaedic Infections
Erin Stockwell, Kent Rinehart, Angela Hewlett, Phlipp Streubel

21-AEP-806 Tourniquet Use is Associated with Improved Outcomes in Aseptic Revision Total Knee Arthroplasty
Vinay Aggarwal, Joseph Robin, Chelsea Sicat, Trevor Simcox, Joshua Rozell, Ran Schwarzkopf, Vivek Singh

21-AEP-804 A covalently bound surface treatment of methacryloyloxydodecyl pyridinium bromide (MDPB) reduces microbial surface contamination in an ex vivo model while also being safe to the viability of mammalian cells, ex vivo.
Gene Kulesha, Zoe Tamton

Monitor 5

21-AEP-886 Distribution of Joint Involvement for Arbovirus-Associated Persistent Arthralgia May Help Distinguish Between Similar Diseases
Shayan Farahani, Federico Palacio

21-AEP-875 Does implant constraint affect outcomes following reimplantation for periprosthetic joint infection in total knee arthroplasty?
Eytan Debbi, Nicolas Sapountzis, Agnes Cororaton, Yu-Fen Chiu, Milan Kapadia, Ioannis Gkiatas, Peter Sculco, Alberto Carli

21-AEP-873 Preoperative Colonization with S. aureus in Total Knee Arthroplasty Informs Readmission Risk
Daniel Santana, Alison Klika, Yuxuan Jin, Ahmed Emara, Carlos Higuera, Nicolas Piuzzi

21-AEP-862 No role of complete blood count in determining outcome of reimplantation in two-stage revision hip and knee arthroplasty
Tejbir Pannu, Jesus Villa, Carlos Higuera, Aldo Riesgo, Alison Klika

21-AEP-860 Vertebral discitis-osteomyelitis and epidural abscess due to Listeria monocytogenes: case report and review of literature
Olayinka Adebolu, Abiodun Idowu , Nicole Lao, Talha Riaz

21-AEP-857 Sex Differences in Prosthetic Joint Infections
Christine Mironenko, Milan Kapadia, Laura Donlin, Mark Figgie, Alberto Carli, Michael Henry, Susan Goodman, Andy Miller

21-AEP-855 Preoperative Colonization with S. aureus in Total Hip Arthroplasty is Associated with Increased Length of Stay
Daniel Santana, Alison Klika, Yuxuan Jin, Ahmed Emara, Carlos Higuera, Nicolas Piuzzi

21-AEP-854 Staphyloccocus lugdenensis in PJI: Operative Management and Treatment Success
Francis Sirch IV, Emanuele Chisari, Leanne Ludwick, Javad Parvizi

21-AEP-847 Is Manually Mixed Povidone Iodine Irrigation Preparation Reliable?
Emanuele Chisari, Noam Shohat, Karan Goswami, Chad Krueger, Javad Parvizi, Edward Schwarz

21-AEP-820 Preliminary study of anesthetic-loaded chitosan-mannitol-PEG paste to reduce S. aureus bioburden.
Emily Coleman, Carlos Wells, Luke Tucker, Zoe Harrison, Lauren Priddy, J. Jennings

21-AEP-807 Tourniquet Use Does Not Impact Outcomes in Revision Total Knee Arthroplasty for Periprosthetic Infections
Vinay Aggarwal, Vivek Singh, Joseph Robin, Chelsea Sicat, Katherine Lygrisse, Joshua Rozell, Ran Schwarzkopf

21-AEP-805 Safety and Effectiveness of Intravenous to Oral De-escalation Compared to Continued Vancomycin Therapy in Orthopedic Infections
Chanah Gallagher, Laura Certain, Russell Benefield

21-AEP-802 16S DNA Deep Sequencing in Culture-Negative Periprosthetic Joint Infections with Draining Sinus Tracts
Gerhard Maale, Nicole Kennard, Aniruth Srinivasaraghavan, Arianna Mixon

21-AEP-801 Antibiotic-loaded Calcium Sulfate Coating vs Antibiotic-loaded PMMA Coating Intramedullary Nails in Septic Complex Extremity Reconstruction
Emilie-Ann Downey, Austin T. Fragomen, S. Robert Rozbruch, Asim Makhdom, Kayla Jaime, Taylor Reif

890 Novel Activated Zinc Solution More Efficacious Against Pseudomonas aeruginosa and MRSA Biofilm Relative to Dilute Chlorhexidine and Povidone Iodine

Authors Derek Hill, Elizabeth Pensler, Andre Castiaux, Paul Attar, Ahmed Siddiqi

Background And Rationale There are limited efficacious and safe options for infection eradication in periprosthetic joint infection (PJI). The ideal solution should have significant bactericidal and anti-biofilm activity to be able to eradicate infection while retaining prosthetic components.

Study Question The purpose of this study was 1.) to investigate the anti-biofilm efficacy of a novel activated zinc solution against P. aeruginosa and MRSA biofilms in vitro and 2.) to compare its efficacy against two leading commercially available antimicrobial irrigants: 0.05% chlorhexidine (CHG) and 0.35% povidone iodine (PI).

Methods A Modified Robbins Device was utilized to produce and test eradication of Pseudomonas and MRSA biofilms. The primary outcome was bacterial reduction after 2-hour biofilm exposure to an activated-zinc solution, CHG, and PI compared to untreated controls.

Results After 2-hours Pseudomonas biofilm exposure to activated zinc, mean recoverable Pseudomonas was 1.65±1.46-log CFUs, representing 5.44-log reduction (99.9996%). After 2-hours exposure to CHG, mean recoverable Pseudomonas was 7.09±1.51-log CFUs, representing 0.38-log reduction (58.3%). After 2-hours exposure to PI, mean recoverable Pseudomonas was 6.40±0.56 log CFUs, representing 0.85-log reduction (85.9%).

After 2-hours MRSA biofilm exposure to activated zinc, mean recoverable MRSA was 0.00±0.00-log CFU, representing 6.83-log reduction and 100% MRSA biofilm eradication. After 2-hours exposure to CHG, mean recoverable MRSA was 4.76±0.97-log CFU, representing 2.07-log reduction (99.1%) of MRSA biofilm. After 2-hours exposure to PI, mean recoverable MRSA was 1.78±2.04-log CFU representing 5.0-log reduction (99.999%) of MRSA biofilm.

Discussion Data were analyzed using ANOVA on log scale. Statistically significant differences between activated zinc reduction of Pseudomonas vs. CHG ($p=0.0004$) and vs. PI ($p=0.04$), as well as between activated zinc reduction of MRSA vs. CHG ($p<0.0001$) and vs. PI ($p=0.03$) were noted.

Conclusion Our results demonstrate that CHG and PI may be suboptimal irrigating agents and should be reconsidered in gram-negative PJI. Our novel activated zinc compound demonstrated 99.9996% reduction in Pseudomonas biofilm and 100% reduction in MRSA biofilm. This novel solution may provide a significant tool in the arsenal to treat and/or prevent PJI and other wound infections.

889 Isothermal Microcalorimetry Improves Accuracy and Time to Diagnosis of Fracture Related Infection

Authors Kyle Cichos, Clay Spitler, Jonathan Quade, Michael Johnson, Joseph Johnson

Background And Rationale Fracture-related infection (FRI) was recently defined with a consensus definition including confirmatory criteria beyond conventional cultures, which have a 10-20% false negative rate and often take 1-5 days for aerobic bacteria and up to 14 days for anaerobic bacteria to grow.

Study Question We asked if isothermal microcalorimetry (IMC) can improve the accuracy and time to detection for diagnosing FRI compared to conventional cultures.

Methods We prospectively collected tissue samples from patients taken to the operating room with concerns for FRI from July 2020 – April 2021. Any prior fracture treated operatively, with hardware in place at the time of presentation to our institution with concerns for infection, was included in the study. Patients were excluded if they had already had hardware removal prior to presentation. Each patient had 2-5 deep tissue cultures obtained during surgery, sent to the clinical microbiology lab at our institution for standard processing ("conventional cultures"). This included homogenization of each tissue sample individually (no pooling of samples) and culturing for aerobic, anaerobic, acid-fast bacilli, and fungal culturing conditions. Aerobic cultures were documented for 5 days, while anaerobic cultures were documented for 14 days. The remaining homogenate from each sample was then taken to the orthopaedic research lab, resuspended in growth media, and analyzed by IMC via the Cal Screener (Symcel, Stockholm, Sweden). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for IMC to diagnose FRI was performed based on the consensus definition of FRI.

Results Overall, there were 101 total patients with 305 tissue samples (mean: 3) obtained and assessed by both conventional culture and IMC. The concordance between conventional cultures and IMC was 88%. IMC had a sensitivity of 87%, specificity of 100%, 86% NPV, and 100% PPV for diagnosing FRI compared to 80%, 94%, 79%, and 97% respectively for conventional cultures. Average time to diagnosis (positive samples only) was 48.8 h for conventional cultures compared to 6.1 h for IMC ($p < 0.0001$). The pathogens identified included 30 different bacterial species, representing both gram positive and negative as well as polymicrobial infections. Additionally, there were 19 total patients on antibiotics prior to presentation for a mean duration of 36 days. In these unique patients, the concordance between conventional cultures and IMC was 75% and IMC had a sensitivity of 85%, specificity of 100%, 67% NPV, and 100% PPV while conventional cultures had a 77% sensitivity, 75% specificity, 50% NPV, and 91% PPV. The average time to diagnosis was 63 h for conventional cultures compared to 6.5 h for IMC ($p < 0.0001$).

Discussion The use of IMC for detection of FRI improves time to diagnosis by up to 40 hours while also representing an improvement in diagnostic accuracy as well. Improved time to diagnosis and accuracy would allow patients to be changed from broad-spectrum antibiotics to pathogen-specific antibiotics and be discharged from the hospital faster, improving antibiotic stewardship and reducing costs for both patients and the healthcare system as a whole as well as reducing morbidity for the patient directly. In addition, IMC performed significantly better than conventional cultures in all metrics for patients who had been on antibiotics prior to presentation.

Conclusion IMC improves diagnostic accuracy and time to detection for FRI in general and, importantly, in cases involving patients on long-term antibiotics and warrants further study for diagnostic utility.

888 Isothermal Microcalorimetry Improves Time to Diagnosis of PJI

Authors Kyle Cichos, Elie Ghanem

Background And Rationale Conventional cultures have long been considered the “gold standard” for diagnosing Periprosthetic joint infection (PJI) following total joint arthroplasty (TJA) but have a 10-20% false negative rate and take 1-5 days for aerobic bacterial growth and up to 14 days for anaerobic bacterial growth.

Study Question We asked if isothermal microcalorimetry (IMC) can improve the accuracy and time to detection for diagnosing PJI after TJA compared to conventional cultures.

Methods We prospectively collected tissue samples from patients undergoing revision or conversion arthroplasty from July 2020 – April 2021. Each patient had 3-5 deep tissue cultures obtained during surgery and sent to the clinical microbiology lab for standard processing (“conventional cultures”). This included homogenization of each tissue sample individually (no pooling of samples) and culturing for aerobic, anaerobic, acid-fast bacilli, and fungal culture conditions. Aerobic cultures were examined for 5 days, while anaerobic cultures were examined for 14 days. The remaining homogenate from each sample was then taken immediately to the orthopaedic research lab, resuspended in various media, and analyzed by IMC via the Cal Screener (Symcel, Stockholm, Sweden). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for IMC to diagnose PJI was also performed based on the International Consensus Meeting criteria.

Results Overall, there were 83 total patients with 346 total tissue samples (mean 4.2) obtained and assessed by both conventional culture and IMC. The concordance between conventional cultures and IMC was 99%. Overall, the sensitivity, specificity, NPV, and PPV were all 100% by both IMC and conventional cultures. The average time to diagnosis (positive samples only) was 52.5 hours for conventional cultures compared to 4.9 hours for IMC ($p < 0.0001$). The pathogens causing positive cultures/IMC were comprised of 12 different bacteria species, including both gram positive and gram negative as well as polymicrobial infections.

Discussion The results of this study indicate that the use of IMC for detection of PJI improves the time to diagnosis by nearly 2 full days. This would allow patients to be changed from broad-spectrum antibiotics to pathogen-specific antibiotics and be discharged from the hospital earlier, improving antibiotic stewardship and reducing costs for both patients and the healthcare system as a whole.

Conclusion IMC improves detection time for diagnosing PJI, and further research is warranted to significantly increase the sample size and determine the utility of this technology as a diagnostic platform.

887 Novel Antibody Disrupts Biofilm Bacteria in a Mouse Model of Spinal Implant Infection

Authors Christopher Hart, Zachary Burke, Benjamin Kelley, Zeinab Mamouei, Micah Ralston, Amr Turkmani, Alexandra Stavrakis, Nicholas Bernthal

Background And Rationale Bacterial biofilms on implants are highly resistant to the host immune response and traditional antibiotic therapy. Spinal implant related infections are particularly difficult to manage as removal of implanted hardware may catastrophically destabilize the spine. Novel therapies to treat biofilm infections are needed to improve patient outcomes. We hypothesize that a novel human monoclonal antibody against bacterial biofilm matrix will reduce bacterial burden in a mouse model of spinal implant infection.

Study Question Does TRL 1068—a human monoclonal antibody against a biofilm scaffolding protein that is conserved across both gram positive and gram-negative species—reduce bacterial burden in a mouse model of spinal implant infection?

Methods The efficacy of TRL1068 was assessed in a mouse model of spinal implant infection. A stainless-steel pin is implanted in the L4 spinous process and inoculated with a bioluminescent strain of S. aureus. Bacterial burden is monitored in vivo. Mice were randomized to treatment on POD 4 and 7 with subcutaneous 15 mg/kg TRL1068, inactive antibody, vancomycin alone, or vehicle control. All treatment groups received BID vancomycin 120 mg/kg on POD 7-21. On POD 35 all animals were sacrificed. Implants and peri-implant tissue were harvested separately and sonicated for CFU analysis.

Results Treatment with TRL1068 + vancomycin accelerated the decline of the bacterial burden compared to the inactive antibody + vancomycin or vancomycin alone as measured by bioluminescence. CFUs were enumerated from 42% (5/12) of implants of mice treated with vancomycin alone and 26% (7/27) of implants in mice treated with the inactive antibody + vancomycin. In contrast, only 3% (1/27) of the mice treated with TRL1068 + vancomycin were found to have an infected implant.

Discussion Implant related infections remain a major burden for patients and health systems. Urgent need exists for more effective and less morbid treatment options.

Conclusion The novel human monoclonal antibody TRL1068 may add a valuable therapy to the armamentarium of treatment options as biofilm disruption facilitates the clearance of otherwise recalcitrant bacterial reservoirs.

886 Distribution of Joint Involvement for Arbovirus-Associated Persistent Arthralgia May Help Distinguish Between Similar Diseases

Authors Shayan Farahani, Federico Palacio, Margaret Powers-Fletcher

Background And Rationale Imported cases of arbovirus infections associated with persistent arthralgia in travelers returning from endemic areas are often misdiagnosed due to overlapping clinical presentations and lack of widely available diagnostic testing. Identifying differences in joint involvement between arboviruses that cause persistent arthralgia may facilitate an earlier diagnosis.

Study Question The purpose of this study was to determine if such distinct joint involvement has been reported in published literature for arbovirus-associated persistent arthralgia.

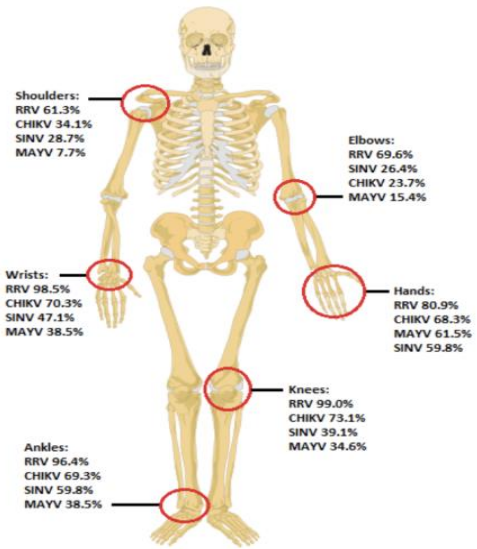
Methods Chikungunya (CHIKV), Ross River Virus (RRV), Sindbis Virus (SINV) and Mayaro Virus (MAYV) were selected for their association with persistent arthralgia. Candidate manuscripts were identified using the PubMed database and search terms included virus names as well as terms associated with persistent arthralgia. Inclusion criteria consisted of 1) patient data on persistent arthralgia and 2) description of joint involvement. Joint involvement data was manually extracted and compared between viruses using a Fisher's exact test. Pairwise post-hoc comparisons were then conducted using Fisher's exact test and a Bonferroni correction was applied.

Results Data from 1,833 patients were extracted from 57 manuscripts that met inclusion criteria (RRV = 194, SINV = 87, CHIKV = 1,526, MAYV = 26). Reported involvement of hands, wrists, elbows, shoulders, ankles and knees were recorded (Table 1). Distribution of joint involvement was then calculated for each virus (Figure 1). The difference in distribution of joint pain between the four arboviruses was statistically significant (P = 0.004). Comparisons revealed RRV and CHIKV are distinguishable from each other (P = 0.004).

Discussion These findings suggest that differences in distribution in joint involvement may exist between patients with persistent arthralgia following arbovirus infection. .

Conclusion Future studies aimed at more clearly elucidating these differences are warranted and may help develop a more rapid and accurate diagnostic algorithm for persistent arthralgia following arbovirus infection

Figure 1. Distribution of Reported Joint Involvement



885 Cannabidiol Failed to Inhibit Staphylococcus aureus Infection in an in vivo Mouse Model of Spinal Implant Infection

Authors Zeinab Mamouei, Christopher Hart, Micah Ralston, Amr Turkmani, Michael Arnold, Michael Le, Nicholas Bernthal

Background And Rationale Previously published literature has reported antibacterial properties of Cannabidiol (CBD) both in vitro and in vivo. To date, CBD has not been evaluated in an in vivo model of implant associated infection.

Study Question A) Does CBD inhibit the biofilm formation of S. aureus in vitro?

B) Does CBD inhibit S. aureus infection in a mouse model of spinal implant infection?

Methods CBD MICs were determined against 1×106 CFU/ml S. aureus MSSA and MRSA. The CBD inhibition of biofilm formation activity was assessed in a 96-well plate using 1×108 CFU/ml of S. aureus. Finally, CBD minimum biofilm eradication concentration was tested against 24h-preformed biofilm of S. aureus in a 96-well plate and on 0.6mm diameter K-wire pins using prestoblue cell viability assay.A mouse model of spinal implant infection was used to evaluate the efficacy of the CBD powder against a bioluminescent strain of S.aureus, Xen36. Eight-week-old C57BL/6 mice were implanted with a 0.1 mm diameter stainless-steel pin press-fit into the L4 spinous process. An inoculum of 1×103 CFUs of Xen36 was inoculated directly onto the implant. 120 mg/kg of CBD powder or vancomycin powder were administered before wound closure. Mice per infected groups: CBD (10), vancomycin (5), control (5); Mice per sterile groups: CBD (2); control (2). Bacterial burdens were measured by longitudinal tracking of the bioluminescence on POD 0, 1, 3, 5, 7, 10, 14, 18, 21, 25, 28 using the IVIS. The animals were sacrificed on POD 28 and implant as well as surrounding tissue CFUs were measured.

Results CBD MICs against the planktonic and biofilm forms of S. aureus MSSA and MRSA strains are summarized in Figure 1-A.

There was no difference in bioluminescence between the infected group treated with CBD powder and the infected control group (Figure 1-B). There was no difference in implant CFUs between the CBD+bacteria and infected control groups (1.5×104 and 1.43×104 CFUs, respectively). There was no difference between the tissue CFUs of the CBD+bacteria and the infected control group (1.78×104 and 2.0 ×104 CFUs, respectively).

Discussion Although CBD had excellent activity against the planktonic and biofilm forms of S. aureus in vitro, it was not successful in inhibiting S. aureus infection in vivo.

Conclusion Intra-wound CBD powder performed no better than infected control for soft tissue and implant CFUs, as well as longitudinal bioluminescence in a mouse model of spinal implant infection.

	MIC (μg/ml)	
	MSSA-Xen36	MRSA-USA300
Planktonic cells (1×10^6 CFU/ml)	2	2
Inhibition of biofilm formation (1×10^8 CFU/ml)	2	4
24h-Preformed biofilm in 96-well plate	128	128
24h-Preformed biofilm on 0.6 mm K-wire pin	128	N/A

Figure 1-A. Antibacterial and anti-biofilm activity of CBD.

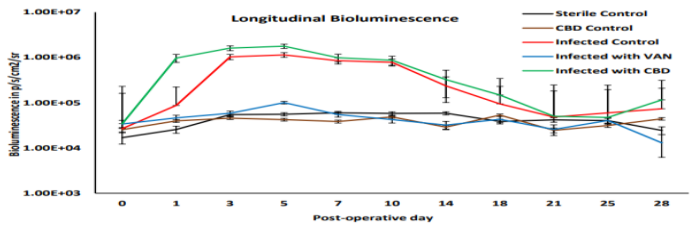


Figure 1-B. Bioluminescent signal over time representing bacterial burden.

884 Trend Towards Reduced Early Bacterial Burden Between Silicon Nitride and Titanium Implants in an in vivo Mouse Model of Periprosthetic Joint Infection

Authors Christopher Hart, Danielle Greig, Zeinab Mamouei, Alan Li, Jeremiah Taylor, Ichiro Nishimura, Nicholas Bernthal

Background And Rationale Silicon Nitride (SN) is a synthetic bioceramic that has been proposed as an alternative orthopaedic implant material. Previously published in vitro and in vivo studies have suggested increased antimicrobial properties of SN relative to other implant materials, including titanium (Ti), stainless steel, and PEEK. This is the first comparison of SN and Ti in an in vivo model of periprosthetic joint infection (PJI).

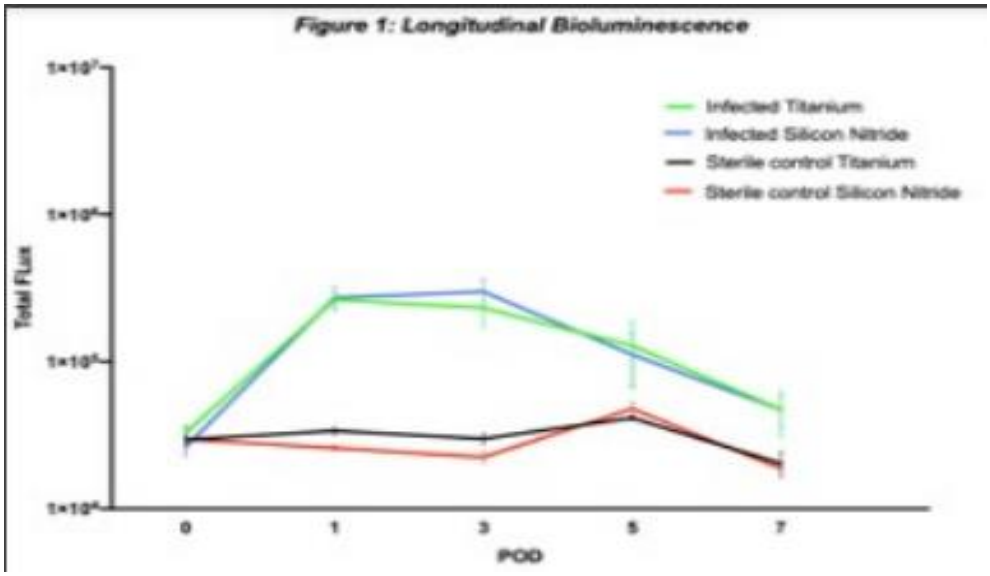
Study Question Is there a difference in bacterial burden as measured by longitudinal bioluminescence, post-operative day (POD) 7 peri-articular tissue colony-forming-units (CFUs), and POD 7 implant CFUs between animals that received Ti versus SN implants in a mouse model of PJI?

Methods 6mm x 0.8mm cylindrical implants made of Ti or SN were inserted into the right distal femur of 8-week-old C57BL/6 mice. 1x 103 of a bioluminescent strain of S. aureus, Xen36, was inoculated into the joint at the time of surgery. Mice per infected group: Ti (8), SN (8); mice per sterile control groups: Ti (2), SN (2). Bioluminescence was measured on POD 0, 1, 3, 5 and 7 to evaluate bacterial burden using the IVIS. The animals were sacrificed on POD 7 and CFUs were determined.

Results Bioluminescence between the infected Ti and SN groups was very similar at each of the time points measured (Figure 1). A 62% decrease in peri-articular tissue CFUs in SN relative to Ti groups (4.9 x 105 (SD 5.4 x 105) and 1.2 x 106 (SD 1.8 x 106) CFUs respectively, p=0.28) was observed. There was an 80% decrease in implant CFUs in SN relative Ti groups (1.6 x 103 (SD 2.7 x 103) and 7.9 x 103 (SD 2.0 x 104) CFUs respectively, p=0.4). However, neither difference was statistically significant. There were no CFUs in any sterile group.

Discussion Because the SN implants are not drug-eluting, we do not necessarily expect a difference in bioluminescence or tissue CFUs between the groups. An 80% reduction in implant CFUs in the SN relative to the Ti groups, while not statistically significant, is notable.

Conclusion In this in vivo mouse model of PJI, we found a trend toward reduced implant bacterial burden in SN compared to Ti groups. More research is required to further elucidate the previously reported antibacterial properties of SN.



883 Application of New Consensus Definition Identifies High Numbers of Fracture Related Infections with Negative Cultures.

Authors Federico Palacio, Kaitlyn Weinert-Stein, Henry C Sagi, Margaret Powers-Fletcher

Background And Rationale Fracture related infection (FRI) is a severe complication in trauma surgery, but defining the full impact of these infections has been challenging with the lack of clear diagnostic criteria. This is particularly problematic for culture-negative FRI (CNFRI), which lack pathogen identification to guide antimicrobial therapy. However, new consensus definition and criteria for the diagnosis of FRI (Table) may help reduce the risk of diagnostic error. The purpose of this study was to determine the proportion and clinical characteristics of CNFRI cases at a level I trauma hospital using the new diagnostic criteria.

Study Question What is the proportion and clinical characteristics of CNFRI cases at a level I trauma hospital using the new diagnostic criteria.

Methods Laboratory reports were used to identify all patients with at least one specimen submitted for microbiology culture by an orthopedic surgeon at our trauma I level hospital in Cincinnati, Ohio during a three-year study period. This cohort was refined by an electronic medical record (EMR) review to select patients that met the diagnostic criteria for suspected/confirmed FRI. The specimen details and results of the cultures were recorded for the first orthopedic surgeon collection for each suspected FRI case. Clinical data, including fracture characteristics, surgical treatment, antibiotic utilization, and patient outcomes were also extracted from the EMR for each case.

Results A total of 246 patients were identified with at least one culture specimen; 35.8% (n = 88) of these were deemed confirmed/suspected FRI based on consensus guidelines. The cultures for the first orthopedic surgery collection on these FRI were negative for 35% (n = 31). The most common location for CNFRI were proximal lower extremity fractures (52%), a distribution different from that of culture positive (Figure). Culture positive FRI were predominated by Staphylococcus aureus (39%) followed by gram negative rods (23%).

Discussion This retrospective cohort study identified a sizable proportion of CNFRI (35%) at our trauma center using the recently published consensus definition. While further analysis is necessary to determine the exact impact of these new criteria, this suggests that clearer definitions may facilitate improved recognition of CNFRI.

Conclusion Because of the relatively high rates of CNFRI, efforts to standardize laboratory diagnostic processes and case management will be required.

Table 1. Diagnostic Criteria as defined by the FRI Consensus Group comprised of experts from the AO Foundation, European Bone and Joint Infection Society, Orthopedic Trauma Association, and PRO-Implant Foundation.

Confirmatory Criteria	Suggestive Criteria
- Fistula, sinus, or wound breakdown (communicating with bone or implant). - Purulent drainage from the wound or presence of pus during surgery. - Phenotypically indistinguishable pathogens identified by culture from at least two separate deep tissue/implant specimens. - Presence of microorganisms in deep tissue specimens, confirmed by histopathological examination. - Presence of more than five PMN/HPF, confirmed by histopathological examination.	- Clinical signs: pain (without weight bearing, increasing over time, new-onset), local redness, local swelling, increased local temperature, fever. - Radiological and/or nuclear imaging signs: bone lysis (at the fracture site, around the implant), implant loosening, sequestration (occurring over time), failure of progression of bone healing (i.e. non-union), presence of periosteal bone formation. - Elevated serum inflammatory markers: WBC, ESR, CRP. - Persistent, increasing, or new-onset wound drainage, beyond the first few days post-operatively without solid alternative explanation. - New-onset of joint effusion. - Pathogenic organism identified by culture from a single deep tissue/implant specimen taken during an operative intervention.

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882 The immune response to bacterial periprosthetic joint infection is heterogenous within the periprosthetic space and is not dependent on PJI chronicity or culture positivity

Authors Alberto V Carli, Sita Nirupama Nishtala, Upneet Sokh,i Tania, Pannellini, Miguel Otero, Lionel Ivashkiv, Mathias Bostrom

Background And Rationale Periprosthetic Joint Infection (PJI) is a devastating complication that can occur following joint arthroplasty. Although immunological assays (synovial WBC, etc) are reliable tools to diagnose PJI, the precise manner by which the immune system responds to PJI remains unknown. Furthermore, it is unclear as to why histological sampling of periprosthetic tissue is not as diagnostically useful. We performed a prospective pilot study investigating quantitative and qualitative features of the immune response to PJI.

Study Question Do immune cell populations vary within PJI samples taken from the same joint? Do cell populations differ in according to chronicity/culture result/previous treatment?

Methods Immunocompetent patients with 2018 MSIS criteria-positive PJI undergoing revision from May to September 2019 were recruited. Five experienced arthroplasty surgeons collected tissue samples following a standardized tissue map. Samples were evenly incised into 3 parts and sent for 1) tissue culture, 2) histological processing for neutrophil grading, 3) cellular composition analysis using flow cytometry. Flow results were compared to 4 patients undergoing revision surgery for aseptic arthrofibrosis. PJI chronicity, culture status, and type of surgery (DAIR/explant/reimplantation) was noted. Statistical differences between groups were analyzed using a Kruskal-Wallis test, with $p<0.05$ denoting significance.

Results 26 patients with MSIS-positive PJI enrolled. Histological evaluation and flow analysis demonstrated substantial variability in infiltrating cells (% CD45+ cells) within tissue samples taken from the same joint (Figure 1A). No significant differences were noted in myeloid or lymphoid cell populations between acute and chronic PJI, nor for culture positive or negative PJI (Figure 1B). Neutrophil populations (CD15+CD16+) were significantly higher in DAIR/explant cases versus reimplantation and aseptic cases ($p<0.01$). Similar trends were observed for non-classical monocytes and histological grading. No significant differences were identified within adaptive immune cell populations (CD19+ B cells and CD3+ T cells) for any conditions.

Discussion The immune response to PJI is heterogenous within the periprosthetic space, justifying the need to collect multiple samples for diagnostic purposes.

Conclusion The immune response to PJI does not appear to vary according to arbitrary clinical parameters, raising the question as to whether such parameters are relevant in the overall pathogenesis of PJI.

Figure 1A

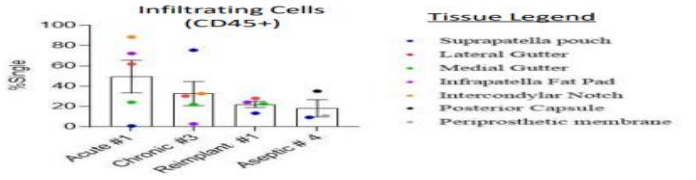
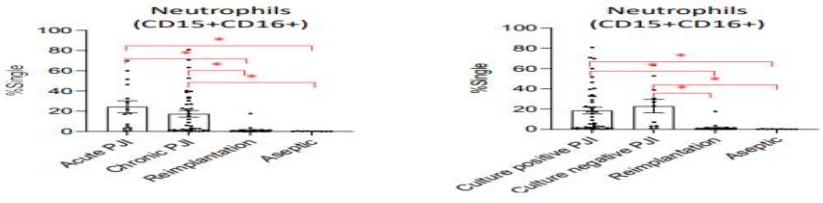


Figure 1B



880 Characteristics of occult infection with non-union repair in patients without clinical or laboratory signs of infection.

Authors Nihar Shah, Federico Palacio, Matthew Frederickson, Ramsey S Sabbagh, Evan Dowell, Julia Slater, Margaret Powers-Fletcher, Henry C Sagi

Background And Rationale Successful treatment of fracture nonunion requires both correct identification of the contributing factors and subsequent selection of appropriate therapy. Recent literature has described occult infections in the setting of nonunion as infections that slow progression of healing but do not present with signs of infection.

Study Question What is the incidence of occult infection in fracture nonunion, its causative organisms, and associated injury or patient characteristics.

Methods Patients who presented to a single Level 1 trauma center with a primary compliant of fracture nonunion from 2014 to 2019 were identified using an institutional database. Patients were excluded for pathologic fractures, nonunion secondary to nonoperative management, and index nonunion repair at an outside hospital. Medical records were reviewed for demographic variables including age at time of nonunion repair, body mass index (BMI), sex, smoking status, diabetes, injury characteristics, culture results, and physical exam and laboratory values at time presentation. Welch's t-tests and chi-squared tests were used to compare characteristics between groups.

Results A total of 327 nonunion patients were identified, 65% (n=211) of whom had no clinical or laboratory signs of infection at presentation. Following operative intervention, 6% (n=13) of these patients had positive intraoperative cultures or gross purulence indicating occult infection. The most common organisms causing occult infection were low virulence Coagulase-negative Staphylococcus and Cutibacterium acnes. Thirty-five percent of (n=116) patients presented with clinical and/or laboratory signs of infection, with 14% (n=16) of these patients having negative cultures. The most common organisms in the infected nonunion group were Methicillin-resistant Staphylococcus Aureus and gram-negative rods.

Discussion There were no significant differences in age, sex, BMI, smoking or diabetes status, or percentage of open fracture between any of the groups. However, patients with occult infection were more likely to be of the upper extremity (62% vs 14%, $p<0.01$) and less likely to involve the tibia (8% vs 64%, $p<0.01$) when compared to those with signs of infection at presentation.

Conclusion The incidence of infection in patients presenting for nonunion repair without clinical or laboratory findings consistent with infection is 6%. Occult infected nonunion occurs primarily in the upper extremity with pathogenic organisms almost exclusively of low virulence (CNSA and C. Acnes). Given the significant incidence of occult infection, it is a prudent rule to obtain specimens for culture and pathology in all patients presenting for nonunion repair.

879 Locked Intramedullary Nail Is Effective as a Static Spacer in Periprosthetic Joint Infection Following TKA

Authors Luke Menken, Richard Yoon, Filippo Romanelli, Jaclyn Jankowski, Frank Liporace

Background And Rationale Periprosthetic joint infection following total knee arthroplasty continues to be a highly morbid complication. Reinfection rates following two-stage exchange are reported to be as high as 41% in the literature.

Study Question What is the infection eradication rate of a proximally and distally locked intramedullary nail as a static spacer in multiply revised patients?

Methods 42 knees in 39 patients were identified as having received locked intramedullary nail static spacers between 2017-2020 at one academic medical center. 2 patients needed 2 static spacers on the ipsilateral limb and are only considered once for reinfection rate. Patients had an average of 2.2 arthroplasty procedures performed on the ipsilateral knee prior to spacer placement. Surgical technique for this construct includes meticulous debridement of all non-viable tissue followed by the use of a reamer-irrigator-aspirator to similarly debride the intramedullary canals. The nail is then placed in the IM canals of the tibia and femur and locked in place. Antibiotic cement is then used in the canals and to create a spacer block in the joint space (3g Vancomycin & 3.6g Gentamicin per bag of cement). A Cox proportional hazard regression was run to identify risk factors for reinfection.

Results 35 patients were reimplanted with a revision total knee arthroplasty or distal femoral replacement. 3 patients died prior to reimplantation, all unrelated to the static spacer placement. 4 additional patients were noncompliant and lost to follow-up after their spacer placement. Reimplantation occurred at a mean of 5.6 months following spacer placement. 7 patients needed a spacer revision prior to reimplantation of their revision TKA. 1 patient had a periprosthetic fracture about the spacer, 1 patient had a sinus tract tracking to the spacer, and 5 patients were found to still be infected at time of revision so a second spacer was placed. Overall, there was an 85% infection eradication rate at an average of 18.0 months following spacer placement. The only risk factors identified on cox regression were increasing number of previous spacers, a surrogate for previous infections (HR=2.8, p=0.03), and increasing operative time during spacer placement (HR=1.01, p=0.002).

Discussion Age, sex, BMI, Charlson comorbidity index, time to reimplant, smoking, alcohol abuse, drug abuse, diabetes, depression, infectious pathogen, and transfusion all were non-significant when analyzed on Cox regression model. Previous infections (p=0.03) and longer operating times (0.002) were the only risk factors associated with reinfection in this cohort. This static spacer construct has proved efficacious even in multiply revised patients. Increased power would likely elucidate additional risk factors for reinfection.

Conclusion Locked intramedullary nail as a static spacer is an effective method of treating multiply revised infected patients.

878 Risk Factors and Characteristics of Recalcitrant Osteomyelitis Following Appropriate Initial Surgical and Antibiotic Treatment

Authors Nihar Shah, Federico Palacio, Arun Kanhere, John Bonamer, Matthew Doyle, Julia Slater, Margaret Powers-Fletcher, Henry C Sagi

Background And Rationale Post-traumatic osteomyelitis is a known complication of fracture treatment which can result in protracted treatment involving multiple surgeries and prolonged antibiotic therapy. There exists a subset of patients who present with recurrent osteomyelitis necessitating repeat debridement despite appropriate treatments the first attempt at eradication.

Study Question What type of injury, patient, and microbiological characteristics place patients at risk for recalcitrant osteomyelitis despite appropriate initial treatment.

Methods Patients undergoing surgical debridement and antibiotic therapy for osteomyelitis from 2003 to 2019 were identified using institutional databases at three Level 1 trauma centers. Patients were categorized as having undergone serial bone debridement if they had two separate procedures a minimum of six weeks apart with a full course of appropriate antibiotics in between. Patient records were reviewed for age, injury location, body mass index (BMI), smoking status, comorbidities, and culture results including the presence of multidrug resistant organisms (MDRO). Multivariate logistic regression was used to identify independent associations between the aforementioned variables and serial debridement events.

Results A total of 244 patients were identified; 52% (n=127) had a successful single course of treatment, and 48% (n=117) underwent repeat debridement for recalcitrant osteomyelitis. At the index treatment, the most common organisms in both groups were Methicillin-resistant (MRSA) and Methicillin-sensitive Staphylococcus aureus (MSSA). Negative cultures at the index procedure were obtained in 24% (n=31) of patients treated successfully and in 16% (n=19) of patients treated unsuccessfully. The most common organisms at the time of repeat saucerization remained MRSA and MSSA, however, the same organism was cultured from both the index and repeat procedure in only 18% (n=21) of cases. Of the patients with a positive culture following initial debridement, 34% (n=40) had a negative culture at the time of repeat procedure. While intravenous drug use, smoking, peripheral vascular disease, BMI, polymicrobial infection, MDRO, and culture negative infections were not associated with failure of initial treatment, diabetes (OR 1.2, p=0.02), open fractures (OR 1.2, p=0.04), and injuries of the lower extremity (OR 1.3, p<0.001) were.

Discussion To our knowledge, this study is the first to specifically examine the implications of patient, organism, and injury characteristics on the treatment of osteomyelitis. Successful eradication of post-traumatic osteomyelitis is difficult to achieve despite appropriate surgical and culture guided antibiotic therapy. .

Conclusion Diabetic patients and open fractures of the lower extremity are independent risk factors for failure of initial treatment of osteomyelitis. While MRSA and MSSA continue to be the most common organisms, patients presenting for repeat saucerization rarely culture the same organism. These findings will help clinicians identify patients who require more careful management prior to definitive reconstruction due to their risk of recalcitrant infection

877 Utility of Magnetic Resonance Imaging in Predicting Failure of DAIR (debridement, antibiotics, and implant retention) for Treatment of Periprosthetic Joint Infection

Authors Alberto Carli, Milan Kapadia, Alissa Burge, Eric Bogner, Peter Sculco

Background And Rationale Debridement, antibiotics, and implant retention (DAIR) is commonly utilized to treat acute periprosthetic joint infection (PJI) of the hip and knee. Performing a thorough debridement of affected tissues is considered essential for DAIR to succeed. Small case series describe occurrences where PJI spreads into adjacent tissues (iliopsoas recess in hips; neurovascular bundle in knees) and bone (osteomyelitis). Surgeons often cite adjacent tissue/bone infiltration as a poor predictor for DAIR since debriding these areas intraoperatively is difficult or not possible. We sought to evaluate this hypothesis by determining if the presence of adjacent tissue/bony lesions on preoperative magnetic resonance imaging (MRI) of hip and knee PJI was associated with poorer DAIR outcomes.

Study Question Do preoperative MRI findings predict treatment success with DAIR in hip and knee PJI?

Methods MSIS criteria-positive hip (n=22) and knee (n=12) PJI cases in our institution from 2010-2020 that underwent preoperative MRI prior to DAIR treatment were evaluated. Demographics, comorbidities, microbiology, chronicity and host grade were recorded. MRIs were assessed by two board-certified radiologists blinded to treatment outcomes, scoring images based on the presence of 18 distinct findings (i.e.: iliopsoas recess extension, extra-articular soft tissue abscesses, osteomyelitis, periosteal reaction, etc). Inter-rater reliability was calculated using bias adjusted Kappa scores. Failure was defined as repeat surgery for PJI. Univariate analysis and logistic regression were used to determine predictors of DAIR success at 90 days and 2 years.

Results When comparing successful and non-successful hip PJI cases, the presence of a psoas recess fluid collection on MRI was significantly predictive of a higher rate of treatment failure at 2 years (odds ratio=0.12; p = 0.045), with a moderate adjusted kappa score of 0.5. With regard to knee PJI cases, capsular disruption (40% [2/5] vs 100% [7/7], p= 0.046) and patellar tendon disruption (25% [1/4] vs 100% [8/8], p = 0.018) were independently associated with higher 90-day failure. However, knee MRI findings were not predictive of failure using regression.

Discussion In this preliminary study, preoperative MRI findings anecdotally linked with PJI treatment failure could be reliably identified. However, few predicted DAIR failure.

Conclusion Further studies are needed to clarify the role of MRI in predicting PJI treatment success.

Table 1. Patient Characteristics and Magnetic Resonance Imaging Findings for Prosthetic Joint Infections in Total Hip and Knee Arthroplasty

	Hip	Knee
n	22	12
Age (mean [SD])	64.6 (12.3)	59.4 (8.4)
BMI (mean [SD])	29.5 (5.8)	31.7 (7.1)
Female (%)	11 (50)	7 (58.3)
McPherson Infection Type (%)		
Acute Postoperative	0 (0)	2 (16.7)
Acute Hematogenous	20 (90.9)	10 (83.3)
Chronic	2 (9.1)	0 (0)
McPherson Host Grade (%)		
A	5 (22.7)	4 (33.3)
B	14 (63.6)	7 (58.3)
C	3 (13.6)	1 (8.3)
Synovium MRI Findings (%)		
Synovitis	22 (100)	12 (100)
Synovial lamellation	16 (72.7)	8 (66.7)
Extracapsular decompression of synovitis	20 (90.9)	10 (83.3)
Bone MRI Findings (%)		
Marrow edema	11 (50)	10 (83.3)
Osseous resorption	4 (18.2)	6 (50)
Loosening	1 (4.5)	2 (16.7)
Soft Tissue MRI Findings (%)		
Sinus tracts	9 (40.9)	1 (8.3)
Non-communicating extracapsular fluid collections	5 (22.7)	1 (8.3)
Lymphadenopathy	14 (63.6)	1 (8.3)
Capsular disruption	19 (86.4)	5 (41.7)
Tendon disruption	8 (36.4)	4 (33.3)
Extracapsular fluid collections MRI Findings (%)		
Subcutaneous, separate from previous incision tract	5 (22.7)	1 (8.3)
Intramuscular, separate from previous incision tract, surgical approach	8 (36.4)	0 (0)
Psoas recess	7 (31.8)	-
Intrapelvic (medial to the acetabular wall)	2 (9.1)	-
Within posterior capsule or posterior to the joint (neurovascular structures)	-	1 (8.3)
Posterior to the distal femur or proximal tibia/fibula	-	3 (25)
Periosteal or endosteal involvement MRI Findings (%)		
Acetabular, behind component, perhaps defined by the DeLee and Charnley Zones	4 (18.2)	-
Femoral, perhaps defined by the Gruen zones	4 (18.2)	-
Further away, in pelvis or femur (a skip lesion)	0 (0)	-
Underneath femoral/tibial components	-	4 (33.3)
Adjacent to stems (if present)	-	0 (0)
Further away, in metaphyseal or diaphyseal bone (a skip lesion)	-	0 (0)

876 How does the definition of treatment success affect outcomes following One-Stage and Two-Stage revision surgery for Periprosthetic Joint Infection? A Systematic Review and Meta-Analysis

Authors Eytan Debbi, Tyler Khilnani, Yu-Fen Chiu, Stephen Lyman, Ioannis Gkiatas, Alberto Carli

Background And Rationale The definition of success following treatment for periprosthetic joint infection (PJI) remains controversial. In 2019, the MSIS working group proposed a tier-based outcome system to stratify definitions of success. The present study is the first systematic evaluation of this system across one-stage and two-stage revision surgery.

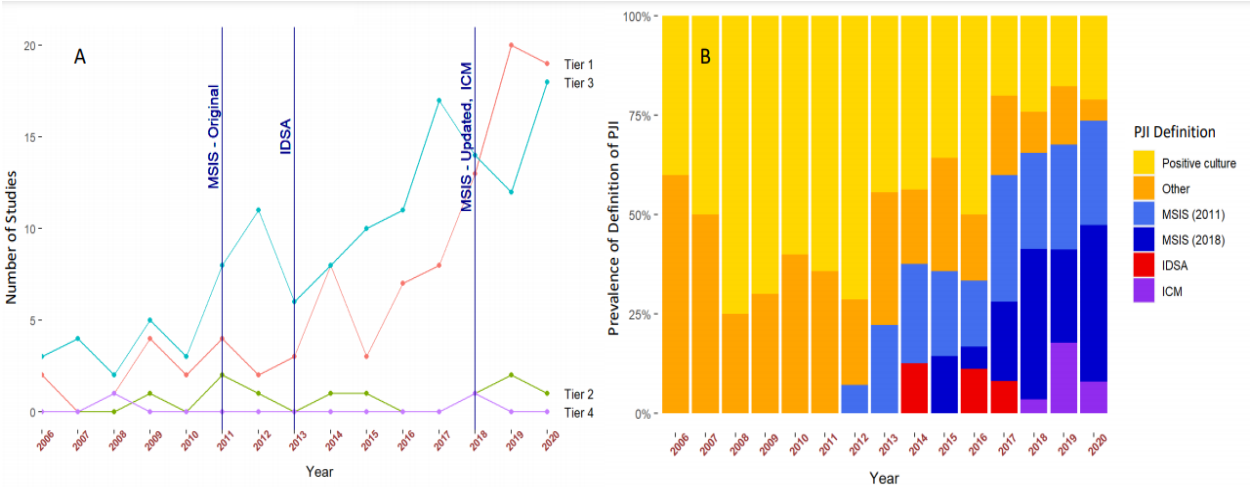
Study Question 1) Quantify the prevalence of different treatment success tiers across the PJI literature over time, 2) Determine how defining treatment success affects outcomes, 3) Determine if study quality relates to the definition of treatment success, and 4) Determine the impact of Delphi-based PJI diagnostic criteria on PJI study quality and treatment success definitions over time.

Methods A systematic review following PRISMA guidelines was conducted to identify eligible one-stage or two-stage revision for PJI publications in major databases from 2006-2020. Studies were screened by three independent reviewers. The publication year, number of patients, definition of PJI, minimum follow-up, definition of treatment success (per the MSIS workgroup tier list) and study quality (per the MINORS criteria) were recorded. Trends in variables were tabulated and multinomial regression models were calculated to determine interactions between variables.

Results 246 publications met the study criteria. PJI publications exponentially increased over time. 62.5% of one-stage studies were Tier-1 studies (strictest definition of success) compared to 33.5% of two-stage studies. PJI studies tended to use stricter definitions of success (Tier-1 and Tier-3) over time (Figure 1A). Regression analysis confirmed that a less strict definition of success (lower Tier) conferred higher treatment success rates ($p<0.05$). This association persisted even when accounting for MINORS score, definition of PJI, publication year and follow-up ($p<0.05$). Over time, the diagnostic definition of PJI shifted considerably toward the use of Delphi-based criteria, especially MSIS definitions (Figure 1B).

Discussion This review is the first evaluation of how the definition of treatment success affects outcome following one and two-stage revision surgeries. Over time, the PJI literature has gravitated towards using stricter definitions of success and a higher use of diagnostic consensus criteria.

Conclusion We advocate that studies should routinely report their outcomes according to the MSIS working group definition, and that journals should avoid publishing Tier-4 based studies.



875 Does implant constraint affect outcomes following reimplantation for periprosthetic joint infection in total knee arthroplasty?

Authors Eytan M Debbi, Nicolas Sapountzis, Agnes Cororaton, Yu-Fen Chiu, Milan Kapadia, Ioannis Gkiatas, Peter Sculco, Alberto Carli

Background And Rationale Two-stage revision for total knee arthroplasty (TKA) periprosthetic joint infection (PJI) often requires different interim spacer designs as well as various levels implant constraint for reimplantation. It is unclear if spacer design or level of constraint affects the possibility of implant loosening.

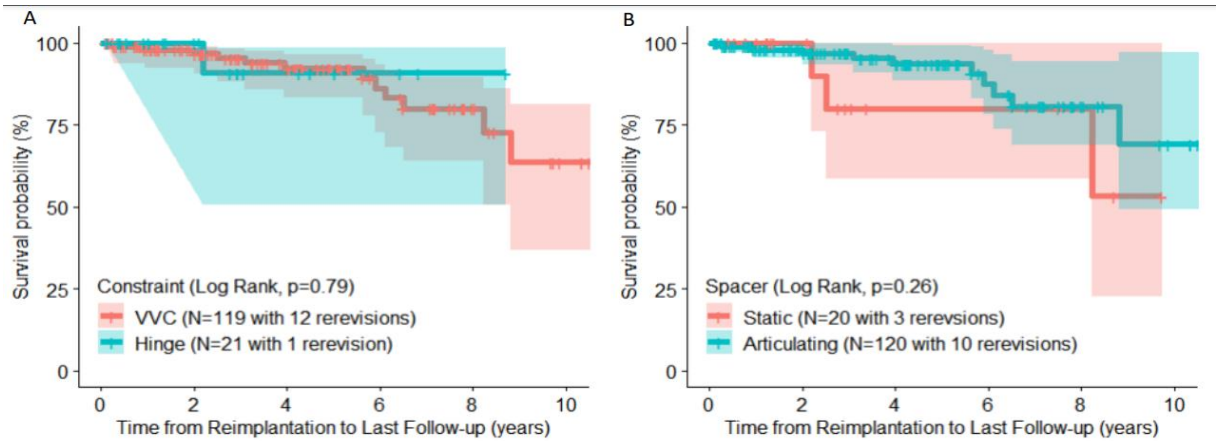
Study Question The purpose of this study was to determine the clinical outcomes after TKA reimplantation based on interim spacer design as well as the level of implant constraint.

Methods This was a retrospective single institution study on patients undergoing two-stage revision for TKA PJI, reimplanted with either a varus-valgus constrained (VVC) or a hinge implant, with successful infection control. Our primary objective was to evaluate the effect of spacer design and the level of implant constraint utilized at reimplantation on rates of aseptic re-revision surgery. Our secondary object was to determine differences in AORI bone loss, reconstructive methods, range of motion and patient reported outcomes.

Results 148 patients (124 VVC; 24 Hinges) were included in the study, with a mean age of 67 years, BMI of 32kg/m2 and Charlson Comorbidity Index of 3. 94 patients had >2 year follow-up (mean 5.2 years). There were no significant differences in re-revisions Kaplan-Meier survivorship curves between VVC and hinge components (p=0.79) or between static and articulating spacers (p=0.26) (Figure 1). Findings did not change when accounting for bone loss, comorbidities or prior revision surgery. The hinge group were more likely to have been treated with a static spacer and had higher usage of femoral and tibial cones/sleeves, greater 2B and 3 AORI bone loss and a mean of 18° less flexion at final follow-up than the VVC group (all p<0.01). There were no significant differences in KOOS or VR12 scores.

Discussion Neither the interim spacer design nor level of constraint at reimplantation appears to have significant effects on rates of aseptic re-revision after two-stage revision for TKA PJI. Patient reimplanted with hinge components are more likely to have been treated with a static spacer, have more severe bone loss and have less range of motion at final follow-up.

Conclusion Patients with TKA PJI treated with two-stage revision are unlikely to have differences in aseptic re-revision rates based on their type of spacer or revision implant but patients with severe bone loss are more likely to receive a static spacer, hinge implant and have less range of motion long term.



874 Improving the Intraoperative Assessment of Biofilm in Prosthetic Joint Infection

Authors Daniel Santana, Anabelle Visperas, Alison Klika, Carlos Higuera, Nicolas Piuzzi

Background And Rationale Prosthetic joint infection (PJI) is major complication of total joint arthroplasty that is challenging to diagnose and to eradicate, in large part due to the formation of biofilm by offending bacterial species. Novel, multi-modal therapies for PJI have been devised but treatment still has a high rate of failure. In part, this may be due to difficulty in diagnosing pathogens, and in identifying regions of high bacterial burden intraoperatively, increasing the risk of incomplete bacterial elimination.

Study Question To review methods of intraoperative assessment of biofilm in PJI for both diagnosis and treatment.

Methods A review of primary literature and society guidelines discussing the intraoperative assessment of biofilm in prosthetic joint infection was performed using the PubMed and Google Scholar databases.

Results ---

Discussion The predominant role of intraoperative findings for making the diagnosis of PJI occurs when the diagnosis is suspected but test results remains inconclusive i.e. neither of the major criteria for diagnosing PJI have been met, and blood and synovial fluid laboratory testing is inconclusive. Techniques for intraoperative assessment of biofilm include assessments of purulence and soft tissue necrosis, evaluation of bacterial viability via cultures, assessment of implant stability, and presence of neutrophils on tissue histology. Even with these methods, however, the diagnosis of PJI may remain inconclusive. The use of biofilm disclosing agents—dyes which preferentially stain biofilm—is an additional technique. Methylene blue has been demonstrated to be a promising addition to PJI diagnosis and therapy as it is practical to incorporate intraoperatively and is cost effective. Intraoperative tissue staining may guide biofilm debridement and could potentially serve as a means by which to index the extent and location of biofilm in PJI for research purposes. Next generation sequencing is an another new technique that may be utilized to identify pathogens in inconclusive or culture-negative PJI.

Conclusion The use of biofilm disclosing agents and next-generation sequencing are potential techniques to aid in the diagnosis and treatment of PJI. Research into these techniques within orthopaedics is still in relative infancy.

873 Preoperative Colonization with S. aureus in Total Knee Arthroplasty Informs Readmission Risk

Authors Daniel Santana, Alison Klika, Yuxuan Jin, Ahmed Emara, Carlos Higuera, Nicolas Piuzzi

Background And Rationale Though Staphylococcus aureus decolonization prior to total knee arthroplasty (TKA) has reduced rates of prosthetic joint infection (PJI), whether colonization is associated with worse non-infectious outcomes of TKA remains unexplored.

Study Question (1) To examine the association between S. aureus colonization and non-infectious TKA outcomes; (2) to identify risk factors for S. aureus colonization.

Methods From 2015-2019, 8,311 patients underwent primary TKA in a single healthcare system and were tested preoperatively for S. aureus nasal colonization. Logistic regression models were constructed to assess the effects of methicillin-sensitive (MSSA) and methicillin-resistant (MRSA) S. aureus colonization on non-home discharge, >1 day length of stay (LOS), improvement in Knee Injury and Osteoarthritis Outcome Score (KOOS) pain subscale (≥minimal clinically important difference [MCID]), KOOS physical function (PS) improvement (≥MCID), 90-day readmission, and 1-year reoperation. Models controlled for patient and hospital related risk factors. To identify risk factors for S. aureus colonization, a multivariable logistic regression model was constructed with patient and hospital related risk factors.

Results After adjustment, S. aureus colonization was a statistically significant predictor of 90-day readmission (Table) and was a valuable element of the predictive model for 90-day readmission (AIC 3.4). Male sex (OR 1.19, 95% CI 1.05-1.34) was a risk factor for colonization, while protective factors were older age (OR 0.99, 95% CI 0.98-0.99), VR-12 MCS (OR 0.99, 95% CI 0.99-1.00, p=0.027), Black race compared to White (OR 0.70, 95% CI 0.57-0.85), and being a former smoker (OR 0.86, 95% CI 0.75-0.97) or current smoker (OR 0.70, 95% CI 0.55-0.90) compared to never smokers.

Discussion Further examination of the effect of pre-operative S. aureus colonization on readmission rates may be warranted given that there would be a logical association between an increased risk of wound infection due to colonization and readmission.

Conclusion The effect of S. aureus colonization on most non-infectious outcomes of TKA is likely confounded by other risk factors, but these data support further investigation into the increased risk of 90-day readmission.

Table. Multivariable Adjusted Effect of *S. aureus* Colonization on Non-Infectious Outcomes

	Non-home discharge				Length of stay >1 day				KOOS pain improvement > MCID			
Variable	aOR	Lower 95% CI	Upper 95% CI	P-value	aOR	Lower 95% CI	Upper 95% CI	P-value	aOR	Lower 95% CI	Upper 95% CI	P-value
S. aureus colonization				0.19				0.40				0.14
Not colonized	ref	ref	ref		ref	ref	ref		ref	ref	ref	
MSSA	1.01	0.81	1.26		0.98	0.83	1.15		1.09	0.86	1.36	
MRSA	1.46	1.01	2.10		1.23	0.90	1.67		1.25	0.75	2.08	

Table cont.

	KOOS PS improvement > MCID				90-day readmission				1-year reoperation			
Variable	aOR	Lower 95% CI	Upper 95% CI	P-value	aOR	Lower 95% CI	Upper 95% CI	P-value	aOR	Lower 95% CI	Upper 95% CI	P-value
S. aureus colonization				0.30				**0.007**				0.06
Not colonized	ref	ref	ref		ref	ref	ref		ref	ref	ref	
MSSA	1.03	0.84	1.27		1.00	0.99	1.01		1.39	1.00	1.93	
MRSA	1.28	0.84	1.97		1.01	1.00	1.01		0.64	0.27	1.55	

P-values by likelihood-ratio test
aOR: adjusted odds ratio

872 Joint age, presence of a sinus tract, and revision arthroplasties influence the microbiology of periprosthetic joint infections

Authors Don Tai, Robin Patel, Matthew Abdel, Elie Berbari, Aaron Tande

Background And Rationale Knowledge of the microbiologic etiology of periprosthetic joint infection (PJI) is essential to its management. Contemporary literature on this topic is lacking in the United States.

Study Question How do types of arthroplasties, the timing of infection, and the presence of sinus tract affect the microbiology of PJI?

Methods An analytical cross-sectional study of patients 18 years of age or older with hip or knee PJI diagnosed between 2010 and 2019 at Mayo Clinic in Rochester, Minnesota, was performed. Timing of infection was categorized as early postoperative if infection occurred within 90 days of most recent surgery, delayed if between 91-365 days, and late if more than 365 days.

Results There were 2,067 episodes of PJI in 1,651 patients diagnosed during the study period. A majority was monomicrobial (70%, n=1,448) and the most common genus causing PJI was Staphylococcus, with coagulase-negative staphylococci being more common as a group than Staphylococcus aureus complex. S. aureus complex, aerobic Gram-negative bacteria, and anaerobic bacteria (other than Cutibacterium species) were more likely to be isolated in the first year following the most recent arthroplasty compared to other organisms (OR 1.7, 95% CI 1.4-2.2; OR 1.5, 95% CI 1.1-2.0; OR 1.5, 95% CI 1.0-2.2, respectively). The proportion of culture-negative PJI was higher in primary than revision arthroplasties (7% versus 3%, p=.0005). The presence of a sinus tract increased the probability of polymicrobial infection almost three-fold (OR 2.6, 95% CI 2.0-3.3).

Discussion Our findings challenge the traditional knowledge of the microbiology of PJI. Coagulase-negative staphylococci outpaced S. aureus complex as overall causes of PJI in this study. Coagulase-negative staphylococci and Cutibacterium species were as likely in early infection compared to late infections. Knowledge of microbiology also has implications on clinical practice. Positive cultures for Corynebacterium species, Enterococcus species, aerobic Gram-negative bacteria, anaerobes (other than Cutibacterium species), fungi, or mycobacteria should alert clinicians on the possibility of polymicrobial infection. Additional empiric Gram-negative and anaerobic antimicrobial coverage may be reasonable to consider in such situations while awaiting final culture results. This is especially true in the presence of a sinus tract or when prior aspirate cultures have not been obtained.

Conclusion Joint age, the presence of a sinus tract, and revision arthroplasties influence the microbiology of PJI. The presence of some microorganisms points to polymicrobial infection.

Table 1. Isolated Microorganisms According to Timing of Infection

Microorganism	Total N=2,067 n (%)	Early N=442 n (%)	Delayed N=305 n (%)	Late N=1,320 n (%)	*P* value*
Aerobic Gram-positive organisms	1698 (82)	372 (84)	260 (85)	1066 (81)	.8
Coagulase-negative *Staphylococcus* species (other than *S. ludgunensis*)	761 (37)	165 (37)	115 (38)	481 (36)	.9
S. aureus complex	497 (24)	140 (32)	79 (26)	278 (21)	<.001
S. ludgunensis	77 (4)	7 (2)	13 (4)	57 (4)	.6
Streptococcus species	287 (14)	36 (8)	48 (16)	203 (15)	<.001
Enterococcus species	155 (8)	38 (9)	20 (7)	97 (7)	.5
Corynebacterium species	105 (5)	32 (7)	16 (5)	57 (4)	.03
Aerobic Gram-negative organisms	222 (11)	57 (13)	43 (14)	122 (9)	.01
Enterobacterales	143 (7)	32 (7)	28 (9)	83 (6)	.2
Pseudomonas species	64 (3)	16 (4)	14 (5)	34 (3)	.1
Anaerobic organisms	262 (13)	72 (16)	35 (11)	155 (12)	.04
Cutibacterium species	164 (8)	45 (10)	20 (7)	99 (8)	.1
Other anaerobic organisms	108 (5)	29 (7)	20 (7)	59 (4)	.1
Fungi	65 (3)	9 (2)	15 (5)	41 (3)	.08
Mycobacteria	12 (0.5)	3 (0.7)	6 (2)	3 (0.2)	.001

* The p-value is for any difference between cells within the row.

871 Are Routine Intra-operative Cultures Necessary During Revision Shoulder Arthroplasty?

Authors Benjamin Zmistowski, Justin Rabinowitz, Vincent Nguyen, Alexander Aleem

Background And Rationale With increasing utilization of shoulder arthroplasty both nationally and globally, the burden of revision shoulder arthroplasty is expected to pose a challenge to the orthopedic community. Complicating the diagnostic work-up for these cases is the limited consensus regarding the diagnosis and management of periprosthetic shoulder infection. Given the high-rate of unexpected positive cultures at the time of both primary and revision arthroplasty, the utility of routine intraoperative cultures remains unknown.

Study Question In this study, we evaluated a large case series of revision shoulder arthroplasty procedures to assess the impact of selective culturing of revision shoulder arthroplasty on subsequent infection and return to the operating room.

Methods In this retrospective case-control study, we identified 376 revision shoulder arthroplasty procedures performed at a single institution between February 2006 and March 2020. The concern for periprosthetic shoulder infection was assessed by each individual surgeon based upon the patient's history, physical examination, radiographic findings, mechanical explanations for arthroplasty failure, serologic markers, and/or pre-revision joint fluid or tissue cultures. Patients without a clinical concern for infection were not routinely cultured at time of revision surgery. Primary outcomes included the rate of positive cultures in patients with intra-operative cultures and the rate of subsequent infection or return to the operating room for infection based upon the use of intra-operative cultures at the time of revision arthroplasty.

Results Overall, 376 revision procedures were eligible for review. There were 65 out of 376 cases (17.3%) in which intra-operative cultures were obtained. Of these cases, 27 (41.5%) had at least one positive culture. Cutibacterium acnes was the most common organism (59.3%) followed by S. epidermidis (14.8%). Of these 65 cases, 13.9% returned to the operating room for infection or for concern for infection, and 21.5% returned for non-infectious reasons. Of the 311 cases not cultured, 3.9% returned to the operating room for infection or concern of infection, and 20.3% returned for non-infectious reasons. The relative risk of return to the surgery for infection or concern for infection for revision procedures in which cultures were not obtained was 0.29 ($p = 0.002$, 95% CI 0.13 – 0.64).

Discussion The clinical significance of positive culture results from revision shoulder arthroplasty remains difficult to interpret. A case-specific approach for the use of intra-operative cultures at the time of revision shoulder arthroplasty did not result in an unacceptable rate of untreated periprosthetic shoulder infections.

Conclusion Selective use of intra-operative cultures may limit the ambiguity and subsequent over-treatment associated with unexpected positive cultures without sacrificing sensitivity for periprosthetic shoulder infection.

Attachments There is no figure for this abstract.

870 Dilute Povidone-Iodine Irrigation Reduces the Rate of Periprosthetic Joint Infection Following Hip and Knee Arthroplasty: An Analysis of 31,331 Cases

Authors Graham Goh, Noam Shohat, Javad Parvizi

Background And Rationale Total joint arthroplasty (TJA) surgeons employ various strategies to reduce the risk of periprosthetic joint infections (PJI). While the use of dilute povidone-iodine irrigation has been advocated in high-risk cases, few studies have examined the role of this preventive measure using a large contemporary cohort taking into account recent practice changes in TJA.

Study Question We asked if the routine use of dilute povidone-iodine irrigation could reduce the rate of PJI in all primary TJA patients, regardless of preoperative risk.

Methods This was a retrospective study of all consecutive primary TJA between 2009 and 2019 at a single institution. We included 31,331 cases, of which 8,659 were irrigated with dilute povidone-iodine and 22,672 were irrigated with saline prior to wound closure. The primary endpoint was the development of PJI as per the 2018 International Consensus Meeting (ICM) criteria with a minimum follow-up of 1 year. Multivariate regression analysis was used to determine the association between dilute povidone-iodine irrigation and PJI while controlling for demographics, comorbidities and operative factors.

Results A total of 340 patients (1.09%) developed PJI. Dilute povidone-iodine irrigation was associated with 2.34 times lower rate of PJI (0.6% compared to 1.3%, p<0.001). In the multiple regression analysis, dilute povidone-iodine remained significantly associated with a reduction in PJI (adjusted odds ratio 0.397, 95% CI 0.283–0.556, p<0.001) (Table 1). The absolute risk reduction (ARR) was 0.73% (95% CI 0.52%–0.95%) and number needed to treat (NNT) was 137 patients (95% CI 105.5–192.6). Gender, American Society of Anesthesiologists score, operative time, anaesthesia type and tranexamic acid were other significant factors in the regression model.

Discussion In this study, the largest series to date that we are aware of regarding this issue, the routine use of dilute povidone-iodine could prevent one PJI for every 137 patients undergoing TJA, regardless of their preoperative risk. The ARR was 0.73%, exceeding the threshold of 0.16% (TKA) and 0.13% (THA) for cost-effectiveness as determined by Kerbel et al.

Conclusion These findings support the use of povidone-iodine irrigation as a safe and cost-effective measure to reduce PJI risk following TJA.

Table 1. Multivariate logistic regression model to identify factors associated with periprosthetic joint infection

Variable*	Adjusted odds ratio	95% Confidence interval	p-value
Age	1.008	0.997-1.019	0.153
Gender, Male	1.660	1.316-2.094	<0.001
CCI	1.054	0.958-1.161	0.280
ASA	1.766	1.405-2.219	<0.001
Operative time (mins)	1.010	1.008-1.012	<0.001
Anaesthesia, Spinal	0.426	0.329-0.551	<0.001
Tranexamic acid	0.507	0.385-0.668	<0.001
Dilute povidone-iodine	0.397	0.283-0.556	<0.001

CCI, Charlson comorbidity index; *ASA*, American Society of Anesthesiologists classification
*Only significant variables in the univariate analysis were included in the regression model

869 Do Pre-Reimplantation ESR/CRP Cut offs Guide Decision Making in Prosthetic Joint Infection? Are We Flying Blind?

Authors Nick Johnson, Taylor Rowe, Michael Valenzuela, Gregory Scarola, Thomas Fehring

Background And Rationale Two-stage reimplantation is a commonly used approach for treating chronic periprosthetic joint infections (PJI). A pre-reimplantation threshold value of erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) to determine infection eradication and the proper timing of reimplantation remains ill defined. Serology is routinely utilized along with clinical impressions to determine readiness for reimplantation.

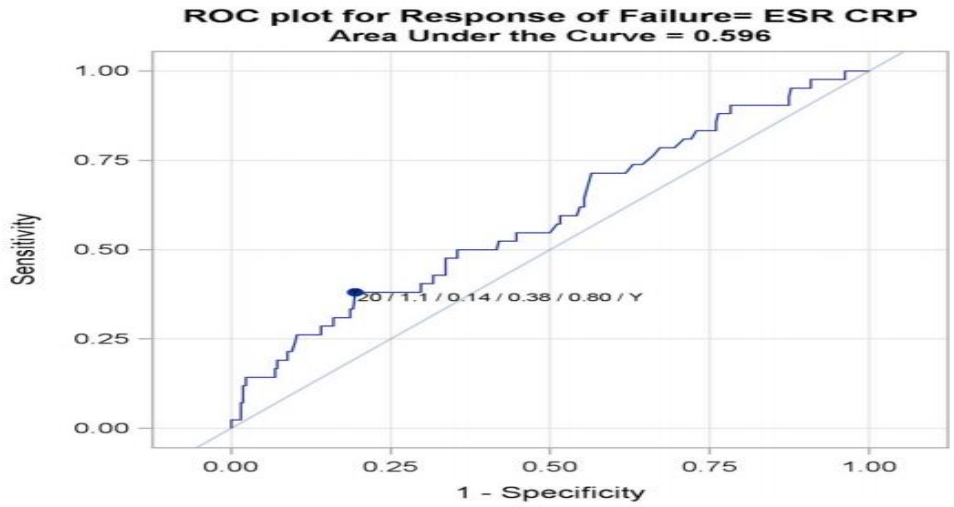
Study Question What serological cutoff values predict failure of two-stage hip or knee reimplantation following periprosthetic joint infection?

Methods We retrospectively reviewed 484 potential patients for eligibility. 178 patients were excluded due to rerevision for infection, ESR & CRP values <8 weeks post resection, significant medical history (cancer, HIV, Liver/Renal failure, etc.), and immunosuppressive drug use at time of reimplantation. 306 patients were eligible who underwent two-stage revision for prosthetic hip or knee joint infection (PJI). Serum ESR and CRP were recorded at 8 weeks post resection prior to stage two reimplantation. ESR and CRP were analyzed with receiver operator curves (ROC) for response failure.

Results 253 patients had resections for chronic infections while 53 septic patients had resections for acute infections. 42/253 (16.6%) failed reimplantation. Median ESR at time of reimplantation was 17 (normal less than 20). Median CRP was .06 (normal less than .05). ROC plot for response failure in analyzing ESR found an area under the curve (AUC) of 0.47. ROC plot analyzing CRP found an AUC of 0.57. The ratio of ESR/CRP was also utilized and found an AUC of .59. All of the AUC data is in the “fail to discriminate category”. For example, < 0.6 on an AUC scale fails to discriminate, 0.6-0.7 is poor, 0.7-0.8 is fair, 0.8-0.9 is good, and 0.9-1.0 is excellent.

Discussion In this study we hoped to provide objective data to guide the optimal timing of reimplantation or need for redebridement in two stage reimplantations for PJI. Unfortunately, in this series of over 250 patients we were unable to determine optimal serologic cut offs using ESR or CRP or the ratio of ESR/CRP.

Conclusion While improvements in serology can be somewhat reassuring, there are no statistically significant values of ESR or CRP that would predict failure of reimplantation in the two stage treatment of PJI.



867 Candida albicans Enhances the Growth and Colonization of Staphylococcus aureus in a Murine Model of Polymicrobial Implant Infection

Authors Zeinab Mamouei, Christopher Hart, Alan Li, Jeremiah Taylor, Amr Turkmani, Micah Ralston, Nicholas Bernthal

Background And 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-infection of SA and CA influences the growth of these microorganisms in a murine model of spinal implant infection.

Study Question How does co-infection of SA and CA impact their growth and colonization in a murine model of spinal implant infection?

Methods An in vivo mouse model of spinal implant infection was used to investigate the level of the microbial burden associated with monomicrobial versus polymicrobial infection. A bioluminescent MRSA strain of SA, AH4775, and a bioluminescent strain of CA, CEC749 were used in this study. Eight-week-old C57BL/6 mice underwent survival surgery in which a surgical-grade 0.1 mm diameter L-shaped stainless-steel implant was press-fit into the L4 spinous process. An inoculum of 1×103 CFUs of SA alone, CA alone, SA + CA, or sterile saline (sterile control) were inoculated directly onto the implant. There were 5 mice in each SA, CA, and SA+CA groups and 2 mice in the sterile control group. Bacterial and fungal burdens were measured by longitudinal tracking of the bioluminescence on POD 0, 1, 3, 5, 7, 10, 12, 14 using the IVIS (PerkinElmer, Waltham, MA).

Results The SA bacterial burden in the SA+CA group significantly increased after POD10 compared to the SA group (Figure 1-A). CA showed the same fungal burden over time in the presence (SA+CA group) and absence of SA (CA group) (Figure 1-B).

Discussion SA infection significantly increased in the presence of CA in a polymicrobial spinal implant model.

Conclusion Co-infection of SA with fungal pathogen CA increased the infection of this bacterial pathogen in an in vivo mouse model of spinal implant infection. However, SA did not influence the fungal burden of CA. Further investigation is required to understand the synergistic mechanisms between these bacterial and fungal pathogens.

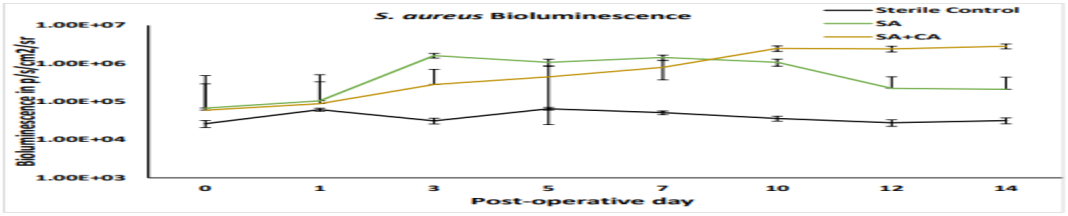


Figure 1-A. Bioluminescent signal over time representing bacterial burden.

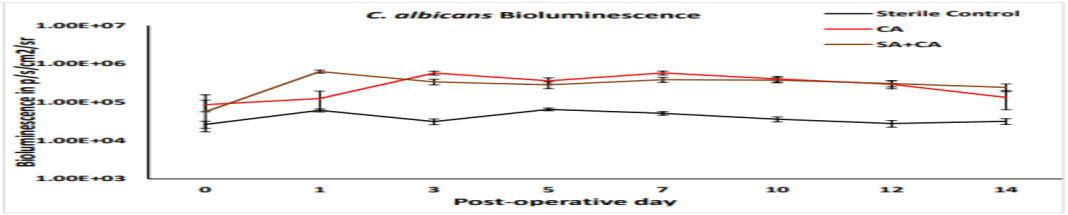


Figure 1-B. Bioluminescent signal over time representing fungal burden.

866 D-Dimer is a Sensitive Marker for Acute Periprosthetic Joint Infection

Authors Ayden Case, Lefko T Charalambous, Trevor Bowman, Ian Duensing, Edward Hendershot, Jessica Seidelman, Thorsten Seyler, William Jiranek

Background And Rationale The diagnosis of periprosthetic joint infection (PJI) is complex and requires a combination of clinical findings, cultures, and laboratory results. Consensus criteria for the diagnosis of acute PJI were updated in 2018 and now include D-dimer. Additionally, Erythrocyte Sedimentation Rate (ESR) is of questionable use in the diagnosis of acute PJI. There is scarce and contradicting evidence on the diagnostic value for these biomarkers, and further studies on larger cohorts are needed for validation.

Study Question What are the sensitivities of D-dimer and ESR in the setting of acute PJI at a tertiary referral center and how do they compare to C-Reactive Protein (CRP) as diagnostic tools?

Methods An institutional database was retrospectively queried for patients undergoing revision procedures for PJI after total hip arthroplasty (THA) and total knee arthroplasty (TKA) from 2014 to present. Patients were included if they had a PJI diagnosis code with subsequent revision procedure CPT codes and Peripherally Inserted Central Catheter (PICC) line placement within 21 days of revision surgery. Patients with inflammatory arthropathies were excluded. Diagnostic labs, including CRP, ESR, and D-dimer, were collected within 90 days pre- and post-operatively, and sensitivities for the diagnosis of PJI were calculated. If multiple labs were collected, the highest value was used. Cutoff values included CRP>1 mg/dL, ESR >30 mm/hr and >50 mm/hr, and D-dimer >860 ng/mL.

Results In total, 961 PJI patients were identified. Of those, 904 had ESR and CRP values collected, and 123 had ESR, CRP, and D-dimer collected. In the cohort of patients with ESR and CRP, 603 patients had elevated CRP, 554 had ESR >30 mm/hr, and 379 had ESR >50 mm/hr, corresponding to sensitivities of 66.7%, 61.3%, and 41.9%, respectively. In the cohort of patients with all three biomarkers, 113 had an elevated D-dimer, corresponding to a sensitivity of 91.9%.

Discussion D-dimer demonstrated higher sensitivity (91.9%) for the diagnosis of PJI than CRP or ESR. There is debate about the value of ESR in the diagnosis of acute PJI and the optimal threshold value. At a threshold of ESR >30 mm/hr, sensitivity (61.3%) was comparable to CRP (66.7%). At a threshold of ESR >50 mm/hr, sensitivity was substantially diminished (41.9%).

Conclusion In this cohort, CRP and ESR were of comparable sensitivity in the setting of acute PJI. D-dimer was the most sensitive.

Table 1. Sensitivities of D-Dimer, ESR, and CRP in acute PJI patients

Diagnostic Lab (threshold value)	Patient count	N over threshold (%)	N under threshold (%)	Sensitivity
D-Dimer (860 ng/mL)	123*	113 (91.9)	10 (8.1)	91.9%
ESR (50 mm/hr)	904**	379 (41.9)	525 (58.1)	41.9%
ESR (30 mm/hr)	904**	554 (61.3)	350 (38.7)	61.3%
CRP (1 mg/dL)	904**	603 (66.7)	301 (33.3)	66.7%

*number of patients with results for all three tests

**number of patients with results for ESR and CRP only

865 Revisiting synovial WBC and PMN% thresholds to determine the outcome of reimplantation in two-stage revision

Authors Tejbir Pannu, Alika Klika, Jesus Villa, Aldo Riesgo, Carlos Higuera

Background And Rationale The 2013 MSIS definition's low sensitivity to confirm infection control before reimplantation is known, but synovial fluid aspiration is still routinely done in some institutions to assess WBC count and PMN%. Using these thresholds to decide the appropriate timing of reimplantation remains questionable.

Study Question To determine the optimal diagnostic thresholds and accuracy for synovial WBC count and PMN% in predicting outcome of reimplantation.

Methods A retrospective review was conducted on a consecutive series of 114 patients in whom two-stage hip or knee arthroplasty was indicated. Operations were performed by 9 surgeons (2014-2020) at a single institution. The inclusion criteria were the completion of reimplantation, and minimum follow-up of 1 year. Of 114, 100 patients (111 reimplantations) were selected, and 71 cases with complete data were analyzed. Surgical success was defined by MSIS outcome-reporting tool: Tier 1 (infection control with no continued antibiotics), Tier 2 (infection control with suppressive antibiotics), vs Tier 3 (need for reoperation or spacer retention), and Tier 4 (death). ROC-curve analyses were performed. The optimal thresholds of synovial WBC count and PMN% to predict outcome were calculated (Youden Index). Kaplan-Meier survival-analysis with log-rank test and Cox-Regression were performed to evaluate these thresholds.

Results The mean follow-up was 15.6±12.3 months. With area under the curve of 0.66, synovial PMN% showed superior accuracy than WBC count (AUC=0.52) in determining outcome of reimplantation. The optimal PMN% threshold was determined to be 57.6% which demonstrated moderate sensitivity (63.5%), and specificity (67.5%). The calculated WBC count threshold (2733/µl) showed poor sensitivity (21%) but high specificity (96%). On survival analyses, there was a significant difference in failure-free survival (11 months) between the cases with PMN% higher vs lower than 57.6% (p=0.02). This was not true for WBC count threshold (p=0.08). PMN% higher than the threshold was significant determinant of MSIS Tier 3 or 4 outcome at minimum 1-year (hazard ratio (HR), 4; P=0.012).

Discussion PMN% threshold (57.6%) shows more accuracy than WBC-count to identify reimplantations which were a success, and can significantly determine survival of reimplantation based on the new MSIS outcome reporting tool.

Conclusion PMN% is a significant predictor of survival of reimplantation in two-stage revision at minimum 1 year.

Table 1. Accuracy of PMN% threshold (57.6%) and WBC count (2733/µl) as determinants of the outcome of reimplantation in two-stage revision.

	MSIS Tier 3&4 Outcome (+)	MSIS Tier 1&2 Outcome (-)	Total
WBC count(-)	15	50	42
WBC count(+)	4	2	29
Total	19	52	71
Accuracy –100 x 3+50/16+3+50+2–74.6%			
Sensitivity –100 x 3/3+16–21%			
Specificity –100 x 50/50+2–96%			
Positive predictive value –100 x 4/4+2–66.6%			
Negative predictive value – 100 x 50/50+15–76.9%			
	MSIS Tier 3&4 Outcome (+)	MSIS Tier 1&2 Outcome (-)	Total
PMN% (-)	7	35	42
PMN% (+)	12	17	29
Total	19	52	71
Accuracy –100 x 12+35/7+12+35+17–66%			
Sensitivity –100 x 12/7+12–63.1%			
Specificity –100 x 35/35+17–67.3%			
Positive predictive value –100 x 12/12+17–41.3%			
Negative predictive value – 100 x 35/35+7–83.3%			

864 Survivorship of Culture Negative Debridement Antibiotics and Implant Retention (DAIR) at 2-Years is Better than Culture Positive DAIR Results

Authors Kyle Alpaugh, Ioannis Gkiatas, T. Tarity, Allina Nocon, William Xiang, Thomas Sculco, Peter Sculco, Michael Cross

Background And Rationale Culture negative (CN) prosthetic joint infection following total joint replacement continues to be a treatment challenge. Little is known about the treatment success of treating CN PJI with a debridement antibiotics and implant retention (DAIR) procedures.

Study Question 1. Evaluate the survivorship of CN periprosthetic joint infection (PJI) treated with DAIR.2. Investigate how concordance between pre-operative aspiration and intra-operative culture specimen growth influence DAIR survivorship.

Methods This is a retrospective study using prospectively collected registry data from patients who underwent a DAIR procedure (N=119) between December 2017 and March 2019. Patients who had DAIR procedures at our institution were included with no exclusionary criteria. All patients included in the study had a minimum of two-year follow-up. CN PJIs were defined as patients whose preoperative aspiration and intraoperative cultures at time of DAIR demonstrated no growth. Preoperative aspiration and intra-operative tissue specimen results were stratified into three groups: concordant-positive (concP), concordant-negative (concN), and discordant (disc). Treatment failure was defined as revision for infection. Mann-Whitney U test and Fisher's exact test were used to determine differences between CN and CP PJI at baseline. Kaplan Meier curve was used to determine survivorship and the log-rang test assessed differences between the curves.

Results DAIR Survivorship Overall mean age and BMI were 69±11 years and 30±7, respectively. The majority of the cohort was male (56%) and of moderate health (ASA2=58%). The cohort was relatively homogenous at baseline between CN and CP PJI in regards to age, BMI, sex, and ASA score (all $p>0.05$). 33 of 119 DAIRs (28%) were CN. Eight (24%) of the CN PJIs had secondary revision for infection.

Overall DAIR survivorship for 119 PJIs was 25% at 2 years. Mean time to secondary revision was seven months. Survivorship for CN PJI was at 54% 2 years compared to CP PJI survivorship of 49% at 2-years. Those who underwent a DAIR procedure but were found to be culture negative survived longer than those who were actually culture positive. However, we did not find a significant difference between the Kaplan Meier curves ($p=0.31$) (Figure 1).

Discordance 95 patients completed preoperative aspiration and intraoperative culture. 17 (18%) patients were found to be discordant while 78 (82%) patients were concordant. Overall, 20% of this cohort required secondary revision. 68% of secondary revisions were performed in concP patients. When stratified DAIR survivorship was highest for the concN group compared to Disc and concP which had lower survivorship at two years (44% vs. 34% vs. 75%; $p=0.80$)

Discussion DAIR for the treatment of presumed PJI has limited survivorship at 2 years. Evaluation of culture concordance revealed that patients with dually negative culture results had slightly better, but statistically insignificant survivorship when compared to patients with at least one positive culture from pre-operative aspirate or intra-operative cultures.

Conclusion DAIR survivorship at 2-years was poor with both CN and CP patients suggesting clinical equipoise.

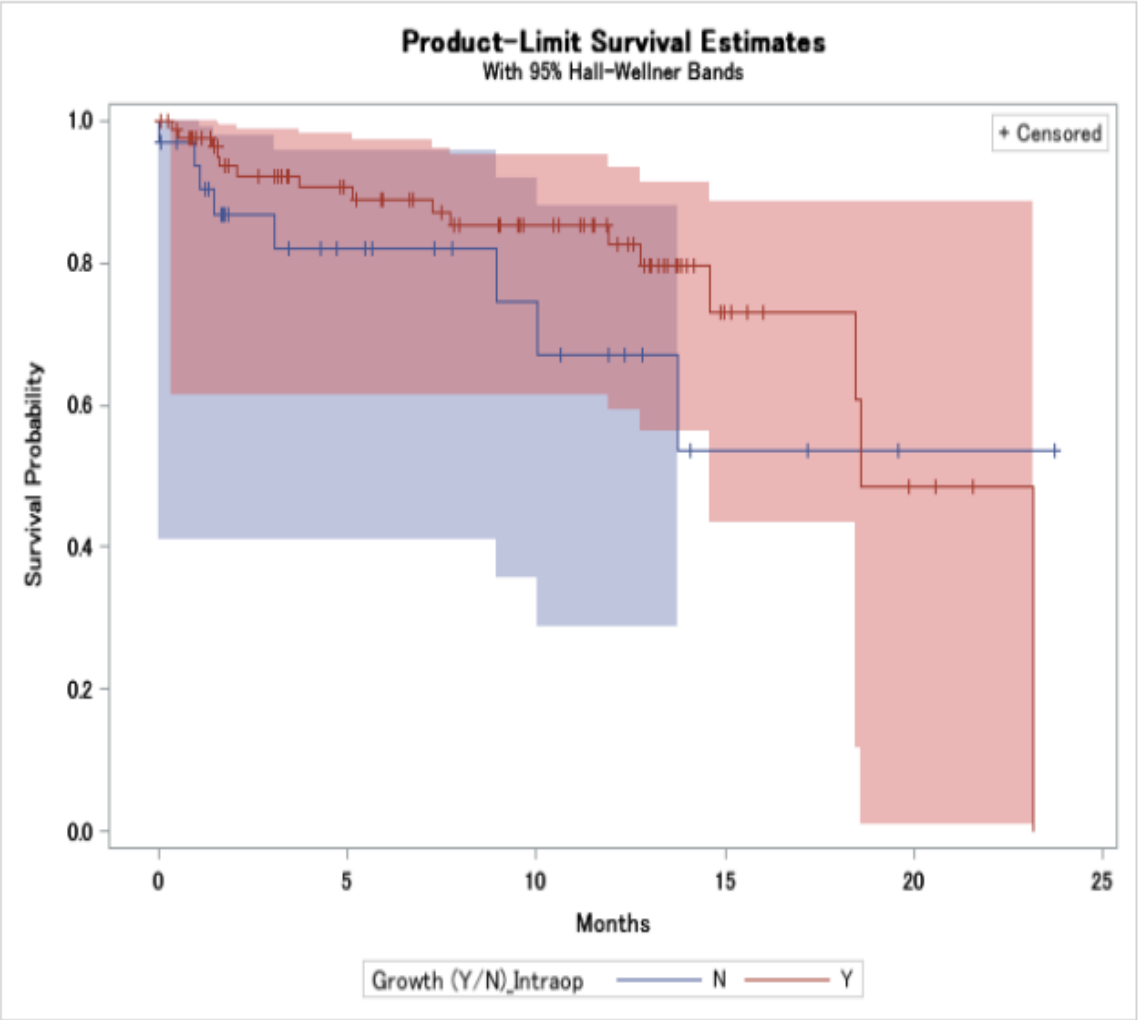


Figure 1. DAIR survivorship based on results of intra-operative culture positivity.

863 Patients with non-Staphylococcal prosthetic joint infections who underwent Debridement Antibiotics and Implant retention (DAIR) and received chronic antibiotic suppression (CAS) were non-significantly less likely to have treatment failure compared to those who did not receive CAS

Authors Poorani Sekar, Rajeshwari Nair, Brice Beck, Bruce Alexander, Kelly Miell, Aaron Tande Kimberly Dukes, Julia Friberg Walhof, Marin Schweizer

Background And Rationale Patients with acute PJI are treated with DAIR. Patients with non-Staphylococcal PJI undergoing DAIR receive 6 weeks of antibiotic treatment. This may be followed by CAS. It is unknown whether these patients benefit from CAS.

Study Question In patients undergoing DAIR for non-Staphylococcal PJI: Is there a difference between those who received CAS and those who did not? Is there a difference in treatment failure between those who received CAS and those who did not?

Methods This is a retrospective study of patients with non-Staphylococcal PJI at Veterans Affairs hospitals. Patients who underwent DAIR for PJI and received 6 weeks of antimicrobial treatment were included. CAS was defined as oral antibiotics given after the initial antimicrobial treatment. Demographic data, patient comorbidities, microbiologic data and treatment outcomes were collected. Chi-square and t-tests were used to compare the two groups. Treatment failure was defined as surgical revision or reinfection after the treatment period. Patients were followed for 5 years. Cumulative incidence function curves were used to compare the incidence of treatment failure among patients who did or did not receive CAS.

Results 483 patients had non-Staphylococcal PJI treated with DAIR. Those who received CAS were less likely to have a Cutibacterium acnes infection compared with those who did not receive CAS. Those who received CAS were non significantly less likely to have treatment failure compared to those who did not receive CAS (unadjusted HR 0.82; 95% CI 0.44-1.52).

Discussion When accounting for death as a competing risk there was a non-significant trend toward decreased treatment failure in patients who received CAS compared to those who did not receive CAS. Our next steps will be to use advanced statistics to adjust for potential confounders. These data can provide evidence for de implementation of CAS in patients who may not benefit from it.

Conclusion Patients who had C.acnes infection were less likely to receive CAS. There were no significant difference between the two groups. Those who received CAS were non-significantly less likely to have treatment failure compared to those who did not receive CAS.

Characteristic	Received CAS N=386 (80.2%)	Did not receive CAS N=95 (19.8%)	Total (N=481)	p-value
Age at debridement, mean (std dev)	66.4 (11.3)	68.4 (11.8)	66.8 (11.4)	0.178
Joint involved				
Hip	86 (22.3%)	21 (22.1%)	107 (22.2%)	0.954
Knee	297 (77.0%)	72 (75.8%)	369 (76.9%)	
Shoulder	3 (0.8%)	2 (2.1%)	5 (1.0%)	
Organism causing the PJI				
Enterococci	72 (18.7%)	12 (12.6%)	84 (17.5%)	0.184
Staphylococci	173 (44.8%)	40 (42.1%)	213 (44.3%)	0.577
Culture negative	28 (7.3%)	11 (11.6%)	39 (8.1%)	0.100
Pseudomonas aeruginosa	35 (9.1%)	3 (3.2%)	38 (7.9%)	0.091
Gram- negative Enterobacteriaceae	155 (40.2%)	35 (36.8%)	190 (39.5%)	0.513
Polymicrobial	28 (7.3%)	2 (2.1%)	30 (6.2%)	0.052
Comorbidities				
Diabetes Mellitus	143 (36.8%)	40 (42.6%)	183 (37.9%)	0.299
Rheumatoid Arthritis	16 (4.1%)	5 (5.3%)	18 (3.7%)	0.585
Renal Failure	43 (11.1%)	6 (6.4%)	49 (10.2%)	0.178
Dialysis	7 (1.8%)	4 (4.3%)	11 (2.3%)	0.125
Severe Liver Disease	7 (1.8%)	0 (0%)	7 (1.4%)	0.121
Endocarditis	5 (0.9%)	1 (1.1%)	3 (0.6%)	0.643
BMI				
Normal	61 (15.7%)	15 (15.8%)	53 (11.0%)	0.888
Overweight	151 (38.1%)	52 (56.5%)	146 (30.5%)	
Obese	184 (44.6%)	20 (23.5%)	244 (50.5%)	
Sex				
Male	374 (96.4%)	91 (96.8%)	465 (96.7%)	0.824
Female	8 (1.8%)	3 (3.5%)	15 (3.1%)	
Immunosuppressing conditions	3 (0.8%)	0 (0%)	3 (0.6%)	0.563
Immunosuppressing medications	15 (3.7%)	7 (7.4%)	19 (3.9%)	0.250
APACHE score (mean and stdev)	39.1 (14.1)	38.5 (15.3)	38.8 (13.7)	0.674
ESR (mean and stdev)	68.5 (34.8)	74.1 (30.8)	69.4 (33.9)	0.215
CRP (mean and stdev)	15.5 (10.4)	11.8 (9.9)	15.1 (10.1)	0.043

862 No role of complete blood count in determining outcome of reimplantation in two-stage revision hip and knee arthroplasty

Authors Tejbir Pannu, Alison Klika, Jesus Villa, Carlos Higuera, Aldo Riesgo

Background And Rationale While the efforts are underway to find a novel test/marker to improve on diagnostic accuracy of periprosthetic joint infection (PJI), recent evidence (PMID: 32773272) brings attention to the use of complete blood count (CBC) for PJI diagnosis. However, not a single study has evaluated the value of CBC results in the setting of reimplantation in 2-stage revision.

Study Question To evaluate the utility of CBC and intercell ratios in diagnosing infection control and eventual outcome of reimplantation.

Methods A retrospective review was conducted on a consecutive series of 1015 revision total hip and knee arthroplasties. Operations performed by 9 surgeons (2009-2020) at a single institution. After comprehensive review of the operative notes, 107 2-stage revisions were identified. The inclusion criteria were the completion of reimplantation and minimum follow-up of 1 year. Of 107, 95 2-stage revisions which met these criteria were finally included. Data collection included CBC, mean platelet volume (MPV) and computation of ratios: platelet count/MPV ratio (PVR), platelet/lymphocyte ratio (PLR), monocyte/lymphocyte ratio (MLR) and neutrophil/lymphocyte ratio (NLR). Treatment success was defined by the MSIS outcome-reporting tool as: Tier 1 (infection control with no continued antibiotics), Tier 2 (infection control with suppressive antibiotics), vs Tier 3 (need for reoperation or spacer retention), and Tier 4 (death). Reciprocal operator characteristic curve analyses were performed. The optimal thresholds of these ratios were calculated using the Youden Index and tested to determine the outcome of reimplantation.

Results The mean follow-up was 29.8±139.6 months. With areas under the curves ranging between 0.42 and 0.54, none of the tested ratios (PVR, PLR, MLR, NLR) showed any ability to differentiate MSIS Tier 1/2 and 3/4 outcome results of reimplantation. The optimal thresholds of PVR, MLR, NLR and PLR were determined to be as follows: 30.9, 0.76, 3.7, and 297, respectively. Out of all, PVR demonstrated the best sensitivity of 41% and MLR the best specificity of 96.2%.

Discussion This data suggests that CBC ratios did not have any ability to differentiate reimplantations which were a failure versus those which were not.

Conclusion CBC ratios have no utility in diagnosing infection control and outcome of reimplantation in two-stage revision at minimum 1 year.

Table 1. Accuracy of complete blood count ratios: platelet-volume ratio (PVR), monocyte to lymphocyte ratio (MLR), neutrophil to lymphocyte ratio (NLR), and platelet to lymphocyte ratio (PLR) to diagnose infection control and determine outcome of reimplantation in two-stage revision.

CBC Ratios	Area Under the Curve	Sensitivity (%)	Specificity (%)
PVR	0.42	41	62.8
MLR	0.54	22	96.2
NLR	0.54	37.5	80.8
PLR	0.48	18.8	86.5
2*2 Tables			
CBC Ratios	MSIS Tier 3&4 Outcome (+)	MSIS Tier 1&2 Outcome (-)	Total
PVR (-)	13	27	40
PVR (+)	9	16	25
MLR (-)	25	50	75
MLR (+)	7	2	9
NLR (-)	25	49	74
NLR (+)	7	3	10
PLR (-)	26	45	75
PLR (+)	6	7	9

861 Are septic-indicated distal femoral replacements more likely to require reoperation and revision than aseptic-indicated DFRs?

Authors Christopher Rothfusz, Nicolas Piuzzi, Ahmed Emara, Alison Klika, Viktor Krebs, Robert Molloy, Carlos Higuera

Background And Rationale Distal femoral replacements (DFR) are utilized as a salvage procedure for severe bone deficiency and/or catastrophic failure of prior total knee arthroplasty (TKA). Periprosthetic joint infections (PJI) are one such pathology increasingly precipitating the use of DFR in non-oncologic patients.

Study Question This study aimed to 1) evaluate whether septic-indicated DFRs were more likely to require reoperation or revision than aseptic-indicated DFRs and 2) to evaluate short-term post-operative outcomes in non-oncologic DFR patients.

Methods A retrospective review of 196 non-oncologic patients receiving DFRs between 2008-2018 at a large North American academic healthcare institution was evaluated. A total of 159 patients had a minimum of 1-year follow up with a mean age of 68.9 ± 12.3 years, 71.1% women (n=113), 82.4% white (n=131), and mean BMI 33.5 ± 8.7 kg/m2. Patients were stratified into septic and aseptic groups (64 [40.3%] vs 95 [59.7%]) for their index DFR based upon MSIS criteria for diagnosis of PJI. Primary outcomes included all-cause reoperation and revision, prolonged length of stay (LOS) beyond 5 days, discharge to skilled nursing facility (SNF), and 90-day readmission. Binary logistic regression analysis for outcomes was performed.

Results There was a significant difference between septic and aseptic groups for age (p<0.001), sex (p=0.021), obesity (p=0.033), history of prior TKA (p<0.001), femoral stem component width (p=0.003), and the use of metal cone augments (p=0.001). The septic cohort had higher rates of all-cause reoperation (p=0.032) and all-cause revision (p=0.035) than the aseptic cohort based on univariate analysis (Table 1). Binary logistic regression indicated that age (odds ratio [OR] 1.01 p=0.002; 95% confidence interval [CI] 1.03-1.13) and BMI (OR 1.07 p=0.031; 95% CI 1.01-1.13) were predictive of discharge to SNF and septic-indicated DFR was predictive of additional all-cause reoperation (p=0.028, OR 2.49; 95% CI 1.10-5.62).

Discussion Half of the septic indicated DFR patients required reoperation versus 33% of aseptic patients within the same time period. High-risk patients at baseline should therefore be counseled regarding postoperative expectations and be aware of the considerable risk of reoperation.

Conclusion DFR for septic indications were 2.5 times more likely to require reoperation than aseptic-indicated DFR for non-oncologic patients and surgeons considering this procedure should be wary of the increased risk when considering this procedure.

Table 1: Uni- and multivariable analysis associations with outcomes of interest for septic- vs aseptic-indicated distal femoral replacements

Univariate Analysis

	Septic (n=64)	Aseptic (n= 95)	p-value
LOS > 5 days	25 (39.1%)	42 (44.2%)	0.519 [c]
Discharged to SNF, n (%)	38 (59.4%)	63 (66.3%)	0.373 [c]
Readmission within <90 days), n (%)	17 (26.6%)	24 (25.3%)	0.854 [c]
Survivorship			
All-cause Reoperation, n (%)	31 (48.4%)	30 (31.6%)	**0.032** [c]
Time to 1st reoperation (years), mean ±SD	0.8 ± 1.6	0.9 ± 1.8	0.838 [a]
Revision, n (%)	24 (37.5%)	21 (22.1%)	**0.035** [c]
Time to 1st revision (years), mean ±SD	1.5 ± 2.7	1.3 ± 2.0	0.827 [a]
Amputation, n (%)	1 (1.6%)	0 (0.0%)	0.222 [c]

Significant results of multivariable analysis

	OR	95% CI	p-value
All-cause Reoperation			
Infection	2.49	1.10 - 5.62	**0.028**
Discharged to SNF			
Age	1.01	1.03 - 1.13	**0.002**
BMI	1.07	1.01 - 1.13	**0.031**

p-values: a = 2-tailed t-test, c = Pearson's chi-square test
LOS: length of stay; SNF: skilled nursing facility; BMI: body mass index; OR: odds ratio; CI: confidence interval

860 Vertebral discitis-osteomyelitis and epidural abscess due to Listeria monocytogenes: case report and review of literature

Authors Olayinka Adebolu, Idowu Abiodunv Nicole Lao, Talha Riaz

Background And Rationale Listeria as an etiology of vertebral osteomyelitis is a rare entity. To the best of our knowledge, only five cases of vertebral osteomyelitis secondary to Listeria have been recorded in the literature (table 1). We report a case of Listeria monocytogenes vertebral osteomyelitis complicated by epidural abscess and review the published literature.

Study Question A 60-year-old man from Northeast Ohio presented to the emergency room with acute exacerbation of lower back pain. He suffered from polymyalgia rheumatica and had been taking 20 mg of prednisone daily for the past one year. On arrival, he reported inability to get up on his feet and was only able to take a few steps due to the pain. He reported multiple falls in the preceding months. Pain radiated down his right leg and he reported numbness and tingling sensations on his right thigh. He worked at a grocery store and frequently handled food. He had chronic diarrhea of unclear etiology. White blood cell count was 14,200/mm3, hemoglobin 11.8 g/dL, C-reactive protein (CRP) was 3.24 mg/dl (ref: <1.0mg/dl), erythrocyte sedimentation rate (ESR) was 64mm/hr (ref: 0-20mm/hr). On non-contrasted Magnetic Resonance Imaging (MRI) of the lumbar spine, he was noted to have abnormal signal within the disc space and subtle signal abnormality along the end plates at L3-4. As well as hyper intense signal on T2 weighted imaging within the epidural space posteriorly and to the left of midline from L2-L3 with marked mass effect on the thecal sac and severe canal stenosis. Given the appearance of the disc space and endplates, there was a concern for epidural abscess. Antibiotics were held and he was taken to the operating room by orthopedic surgery. He underwent irrigation and debridement including levels L2, L3 and L4 laminectomy and decompression of the epidural abscess (intraoperative purulence was noted). Aerobic and anaerobic cultures were sent along with Gram stain. Medial facetectomy and foraminotomy L2-4 and lateral decompression of the L2, L3 and L4 nerve roots was done bilaterally. Post-operatively, he was started on intravenous vancomycin and piperacillin- tazobactam. Two sets of blood cultures collected prior to initiation of antibiotics were positive for Listeria monocytogenes (in all 4 bottles) identified via matrix-assisted laser desorption/ionization- time of flight (MALDI-TOF) mass spectrometry. Epidural phlegmon also grew Listeria monocytogenes. One out of two sets of blood cultures drawn 24 hours after surgery was positive for Listeria again. Subsequent two sets of blood cultures collected 48 hours after surgery were negative. Pathology specimens from the lumbar region were noted for fibrous and fatty tissue with acute on chronic inflammation and areas of tissue necrosis consistent with abscess tissue. Gram stain was negative for any microorganisms.

Methods A transthoracic echocardiogram was suboptimal due to body habitus so the patient underwent a trans-esophageal echocardiogram (TEE). TEE was negative for any valvular disease; however, a questionable band was noted in the right ventricle deemed to be moderator band per cardiology. He was treated with a 2 weeks course of gentamicin and 6 weeks course of ampicillin (which was later given via continuous infusion pump, 12 grams per day). A non-contrasted MRI of the lumbar spine done at 6 weeks was noted for post surgical changes with persistent evidence of discitis and osteomyelitis at L3-L4. However, he reported improvement in back pain and was rehabilitating well. He was noted to have a wound at his surgical site with granulation tissue and erythematous base. He was transitioned to oral amoxicillin 500 mg every 8 hours while allowing the wound to heal via secondary intention. A subsequent MRI of his lumbar spine without contrast 6 months postoperatively was noted for significant improvement in the previously noted T2 hyperintensity at L3-L4 level with improvement in marrow in disc signal.

Results Listeria is rarely a cause of NVO. In a 10-year retrospective study of the organisms.....

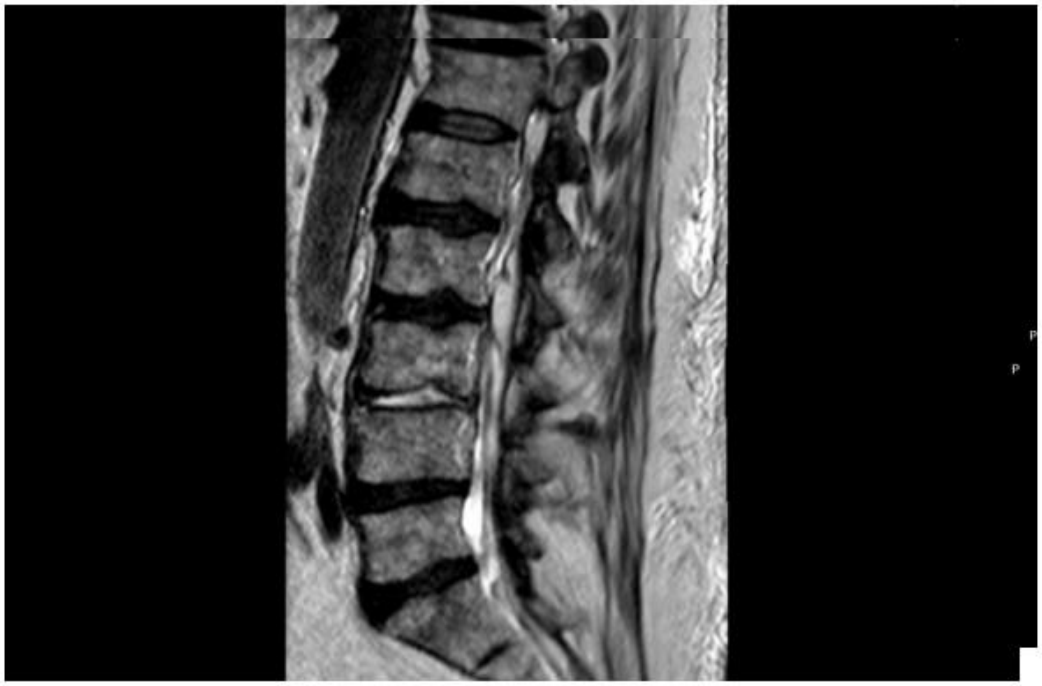


Image 1: Non contrasted MRI of lumbar spine (T2 weighted) showing epidural abscess and disc space enhancement (arrow)

857 Sex Differences in Prosthetic Joint Infections

Authors Christine Mironenko, Milan Kapadia, Laura Donlin, Mark Figgie, Alberto Carli, Michael Henry, Susan Goodman, Andy Miller

Background And Rationale Male sex has been demonstrated to be a non-modifiable risk factor for prosthetic joint infection (PJI) incidence in multiple studies. Given the known anatomical, genetic, and immunological differences between sexes, we compared PJI presentation, treatment and outcomes between men and women.

Study Question Are there clinical differences in PJI presentation, microbiology, septic revision choice, and treatment outcome between men and women?

Methods A retrospective cohort of total hip and knee arthroplasty PJIs from 2009 to 2019 were identified using a single institution PJI database. Included cases met the 2013 MSIS criteria. Demographics, microbiology, acuity (defined by implant age and symptom days), and surgical outcomes were collected. Success was defined as no further PJI surgery at two years. Continuous variables were tested with either Student's t test or Mann-Whitney U test. Categorical variables were tested with either the Chi-squared test or Fisher's exact test.

Results We identified 1061 PJI patients, 468 (44.1%) were women. In univariate analysis of the total cohort, women were older (68.1 ± 11.2 vs 66.1 ± 11.8 years, p=0.01) and had higher BMIs (30.8 ± 7.78 vs 29.9 ± 6.0, p=0.06) than men. There were no sex differences in Charlson Comorbidity Index scores. Microbiology was similar between the sexes. However, women had more culture negative infections (13.9% vs. 9.3%, p=0.02) and men were noted to have more c. acnes infections. (12 (2.6 %) 32 (5.4%) p=0.03) In a sub analysis of hip PJIs, women presented with more acute hip PJIs than men. (29.9% vs 20.9%, p=0.03) This remained true after controlling for age, BMI, and comorbidities (OR 1.79 CI 1.15-2.83, p= 0.01) There were no sex differences in debridement, antibiotics, and implant retention (DAIR) utilization (48.2% vs 44.1%, p=0.067) or difference in overall treatment success at two years (Outcome 2y = 1 (%) 765 (72.1) 339 (72.4) 426 (71.8) p=0.9)

Discussion Although females may present differently when diagnosed with PJI, overall outcomes and outcomes with respect to acuity and type of septic revision did not clearly differ in this single-center cohort. Further research in larger cohorts, including additional biomarkers and socioeconomic variables, may further elucidate relationships between sex and PJI characteristics including culture-negativity and symptom acuity.

Conclusion This study suggests that sex differences in prosthetic joint infection exist and should be studied further. Future studies in larger cohorts are needed. Sex differences in PJI have important implications for epidemiology, risk stratification models, diagnosis, and treatment.

Table 1. Total Hip and Knee Prosthetic Joint Infection Characteristics by Sex

	Overall	Female	Male	p
n	1061	468	593	
Age (mean (SD))	66.98 (11.56)	68.13 (11.17)	66.07 (11.79)	**0.004**
Body Mass Index (mean (SD))	30.24 (6.80)	30.72 (7.75)	29.87 (5.96)	**0.056**
joint = Knee (%)	572 (53.9)	257 (54.9)	315 (53.1)	0.603
Surgical Treatment (%)				0.062
One stage exchange	54 (5.1)	29 (6.2)	25 (4.2)	
Two stage exchange	517 (48.7)	212 (45.3)	305 (51.4)	
DAIR	490 (46.2)	227 (48.5)	263 (44.4)	
History of PJI (%)	106 (10.0)	48 (10.3)	58 (9.8)	0.875
Charlson Comorbidity Index (%)				0.140
0	483 (45.8)	219 (47.2)	264 (44.7)	
1	368 (34.9)	160 (34.5)	208 (35.3)	
2	128 (12.1)	61 (13.1)	67 (11.4)	
3 or more	75 (7.1)	24 (5.2)	51 (8.6)	
Erythrocyte Sedimentation Rate (median [IQR])	52 [33, 79]	57 [40, 90]	48 [29, 71]	**<0.001**
C-Reactive Protein (median [IQR])	6.4 [3.0, 18.6]	6.6 [3.2, 17.2]	6.6 [2.9, 18.8]	0.425
Synovial White Blood Cell Count (median [IQR])	34825 [13525, 77343]	32750 [12125, 73700]	35000 [14050, 80110]	0.357
Infection within 90 days of index surgery = 1 (%)	260 (24.5)	127 (27.1)	133 (22.4)	0.089
McPherson Infection Type (%)				0.168
Acute Postoperative	126 (11.9)	65 (13.9)	61 (10.3)	
Acute Hematogenous	467 (44.0)	197 (42.1)	270 (45.5)	
Chronic	468 (44.1)	206 (44.0)	262 (44.2)	
Treatment success at 2 years (%)	765 (72.1)	339 (72.4)	426 (71.8)	0.883
Microbiology (%)				
Methicillin-sensitive Staphylococcus aureus = TRUE (%)	231 (21.8)	97 (20.7)	134 (22.6)	0.510
Methicillin-resistant Staphylococcus aureus = TRUE (%)	81 (7.6)	39 (8.3)	42 (7.1)	0.519
Coagulase Negative Staphylococcus = TRUE (%)	254 (23.9)	105 (22.4)	149 (25.1)	0.343
Streptococcus = TRUE (%)	168 (15.8)	68 (14.5)	100 (16.9)	0.343
Enterococcus = TRUE (%)	61 (5.7)	31 (6.6)	30 (5.1)	0.340
C. acnes = TRUE (%)	44 (4.1)	12 (2.6)	32 (5.4)	**0.032**
Other Gram Positive = TRUE (%)	58 (5.5)	23 (4.9)	35 (5.9)	0.571
Gram Negative = TRUE (%)	114 (10.7)	59 (12.6)	55 (9.3)	0.101
Fungal = TRUE (%)	8 (0.8)	4 (0.9)	4 (0.7)	1.000
Polymicrobial = TRUE (%)	77 (7.3)	37 (7.9)	40 (6.7)	0.546
Culture Negative = TRUE (%)	120 (11.3)	65 (13.9)	55 (9.3)	**0.024**

856 Oxidized Zirconium vs Cobalt Chrome for Primary Total Knee Arthroplasty: No Difference in Infection Rates

Authors Anirudh Gowd, Edward Beck, Samuel Rosas, Tianyi Luo, John Matthews, Johannes Plate

Background And Rationale Oxidized Zirconium has recently received attention as an alternative to Cobalt Chrome implants as in vitro models have suggested there to be a reduction in polyethylene wear. However, there is limited clinical data detailing mid-term outcomes following primary total knee arthroplasty (TKA).

Study Question Does the decision to utilize oxidized zirconium vs cobalt chrome implants result in significant differences with respect to infection, revision, or patient reported outcomes in the mid-term.

Methods Using AJRR data from 2012 to 2020, primary procedure cases were assessed. The main exposure variables were oxidized zirconium and cobalt chrome, both defined using catalog numbers obtained from device manufacturers. For subsequent revision, cases of oxidized zirconium and cobalt chrome reported to the AJRR database from 2012-2020 and CMS claims data from 2012-2017 were analyzed in a competing risk survival analysis, with the competing event being death. Multivariable logistic regression analysis was used to evaluate the association between minimal clinically important difference (MCID) achievement and metal type adjusting for potential confounders. Revision rates were subcategorized by infection, aseptic loosening, instability, and pain.

Results A total of 441,605 patients met inclusion/exclusion criteria (68,506 Zirconium, 373,099 Cobalt Chrome). There were 28,880 (42.2%) and 142,579 (38.2%) patients that received surgery between the ages of 60-69 for Zirconium and Cobalt Chrome, respectively. A total of 1.3% of zirconium implants were revised in comparison to 1.1% in cobalt chrome ($p=0.006$). Of these revisions, for cobalt chrome and zirconium respectively, 29.7 vs 26.8% were due to infection, 17.2 vs 13.5% were due to aseptic loosening, 11.8 vs 18.1% were due to instability, and 7.9 vs 10.3% were due to pain. Upon multivariate analysis, metal was not associated with increased risk of revision ($p=0.951$), while younger age ($p<0.001$), female gender ($p=0.004$), and large hospitals ($p<0.001$) were associated with increased risk of revision. A total of 4,263 patients (502 Zirconium, 4,761) were available for analysis of patient-reported outcomes. A total of 88.9% of patients with Cobalt Chrome implants achieved MCID for the KOOS-JR score in comparison to 87.8% of patients with Zirconium implants ($p=0.47$).

Discussion Using the reputable AJRR database, the present study did not demonstrate significant differences in multiple outcomes between use of oxidized zirconium vs cobalt chrome in primary total knee arthroplasty in the mid-term. It is particularly useful to note negligible difference in infection rates. This information is beneficial in patient populations with nickel allergies, as zirconium implants minimize sensitivities without greater risk of revisions in the mid-term. Furthermore, additional clinical study may be warranted to investigate long-term benefits of zirconium implants, particularly with regard to implant wear.

Conclusion Oxidized Zirconium implants may be a reasonable alternative to Cobalt Chrome for primary TKA as there are no significant differences in mid-term clinical outcomes, revision rates, or infection rates. Continued follow-up will be beneficial to determine overall survivorship.

Table 1. Demographic Summary

N=441,605	Total	Oxidized Zirconium (n=68,506)	Cobalt Chrome (n=373,099)
AGE			
<50	13,536 (3.1)	2,952 (4.3)	10,584 (2.8)
50-59	80,635 (18.3)	16,633 (24.3)	64,002 (17.2)
60-69	171,459 (38.8)	28,880 (42.2)	142,579 (38.2)
70-79	136,080 (30.8)	16,158 (23.6)	119,922 (32.1)
80-89	38,314 (8.7)	3,712 (5.4)	34,602 (9.3)
90+	1,581 (0.4)	171 (0.2)	1,410 (0.4)
SEX			
Female	273,929 (62)	43,444 (63.4)	230,485 (61.8)
Male	167,376 (37.9)	24,984 (36.5)	142,392 (38.2)
Missing	300 (0.1)	78 (0.1)	222 (0.1)
REGION			
Northeast	79,980 (18.1)	13,746 (20.1)	66,234 (17.8)
Midwest	139,775 (31.7)	24,692 (36.1)	115,083 (30.9)
South	107,636 (24.4)	15,414 (22.5)	92,222 (24.7)
West	113,651 (25.7)	14,554 (21.3)	99,097 (26.6)
Missing	563 (0.1)	100 (0)	463 (0)
POLYETHYLENE COMPOSITION			
Conventional Polyethylene	146,797 (33.2)	9,029 (13.2)	137,768 (36.9)
Antioxidant Polyethylene	185,177 (41.9)	2 (0)	185,175 (49.6)
Highly Cross-Linked Polyethylene	91,020 (20.6)	56,785 (82.9)	34,235 (9.2)
Missing	18,611 (4.2)	2,690 (3.9)	15,921 (4.3)
CEMENT FIXATION			
Cementless	4,099 (0.9)	0 (0)	4,099 (1.1)
Cemented	395,143 (89.5)	65,561 (95.7)	329,582 (88.3)
Hybrid	11,393 (2.6)	20 (0)	11,373 (3)
Missing	30,970 (7)	2,925 (4.3)	28,045 (7.5)
TEACHING STATUS			
Major	75,988 (17.2)	16,980 (24.8)	59,008 (15.8)
Non-Teaching	113,045 (25.6)	15,213 (22.2)	97,832 (26.2)
Minor	243,082 (55)	34,300 (50.1)	208,782 (56)
Missing	9,490 (2.1)	2,013 (2.9)	7,477 (2)
HOSPITAL BED SIZE			
Small (1-99)	79,993 (18.1)	13,126 (19.2)	66,867 (17.9)
Medium (100-399)	216,014 (48.9)	31,335 (45.7)	184,679 (49.5)
Large (≥400)	133,667 (30.3)	21,278 (31.1)	112,389 (30.1)
Missing	11,931 (2.7)	2,767 (4)	9,164 (2.5)
Revisions			
Infection		237 (26.8)	1,330 (29.7)
Aseptic Loosening		119 (13.5)	769 (17.2)
Instability		160 (18.1)	529 (11.8)
Pain		91 (10.3)	352 (7.9)
Periprosthetic Fracture		0	65 (1.5)
All Other Reasons		191 (21.6)	871 (19.4)

855 Preoperative Colonization with S. aureus in Total Hip Arthroplasty is Associated with Increased Length of Stay

Authors Daniel Santana, Alison Klika, Yuxuan Jin, Ahmed Emara, Carlos Higuera, Nicolas Piuzzi

Background And Rationale Staphylococcus aureus is the most common organism implicated in prosthetic joint infection (PJI) of total hip arthroplasty (THA), prompting preoperative decolonization to reduce rates of PJI. However, whether S. aureus colonization is associated with non-infectious outcomes of THA remains unexplored.

Study Question (1) To examine the association between pre-operative S. aureus nasal colonization and non-infectious outcomes of THA; and (2) to examine risk factors for S. aureus colonization.

Methods 6,696 patients underwent primary THA in a single healthcare system from 2015-2019 and were cultured preoperatively for methicillin sensitive (MSSA) or methicillin resistant S. aureus (MRSA). Logistic regression models were constructed to assess the effect of S. aureus colonization on non-home discharge, >1 day length of stay (LOS), improvement in Hip Disability and Osteoarthritis Outcome Score (HOOS) pain subscale greater than the minimal clinically important difference (MCID), HOOS physical function short form (PS) improvement greater than MCID, 90-day readmission, and 1-year reoperation. Patient and hospital related risk factors were adjusted for. To assess risk factors for S. aureus colonization, a logistic regression model was constructed including the same risk factors.

Results S. aureus colonization was a statistically significant predictor of LOS >1 day (Table) and demonstrated a large AIC for LOS (AIC 10.8), but not other outcomes of THA. Male sex (OR 1.26, 95% CI 1.09 to 1.45) and BMI (OR 1.02, 95% CI 1.01 to 1.03) were statistically significant patient-related risk factors for S. aureus colonization, while protective factors were older age (OR 0.99, 95% CI 0.98 to 0.99) and Black race compared to White (OR 0.64, 95% CI 0.50 to 0.82)

Discussion Both MSSA and MRSA colonization were associated with increased LOS, with a greater effect for MRSA than MSSA, which aligns with our general expectation that MRSA would have a greater adverse effect than MSSA.

Conclusion S. aureus colonization was an independent risk factor for increased LOS after THA despite preoperative decolonization, and contributed meaningfully to this predictive model. Further understanding of this association may be warranted.

Table. Multivariable Logistic Model of Effect of *S. aureus* Colonization on Non-Infectious Outcomes

	Non-Home Discharge				Length of Stay >1 day				HOOS Pain Improvement > MCID			
Variable	aOR	Lower 95% CI	Upper 95% CI	P-value	aOR	Lower 95% CI	Upper 95% CI	P-value	aOR	Lower 95% CI	Upper 95% CI	P-value
S. aureus Colonization				0.16				<0.001				>0.99
Not colonized	ref	ref	ref		ref	ref	ref		ref	ref	ref	
MSSA	1.08	0.86	1.38		1.31	1.08	1.60		0.99	0.80	1.22	
MRSA	1.38	0.89	2.15		1.88	1.24	2.85		0.87	0.54	1.40	

Table. cont.

	HOOS PS Improvement > MCID				90-day Readmission				1-year Reoperation			
Variable	aOR	Lower 95% CI	Upper 95% CI	P-value	aOR	Lower 95% CI	Upper 95% CI	P-value	aOR	Lower 95% CI	Upper 95% CI	P-value
S. aureus Colonization				0.10				0.29				0.08
Not colonized	ref	ref	ref		ref	ref	ref		ref	ref	ref	
MSSA	1.01	0.80	1.28		0.94	0.71	1.25		0.70	0.40	1.23	
MRSA	1.38	0.70	2.72		1.30	0.79	2.12		0.93	0.33	2.57	

P-values by likelihood-ratio test

854 Staphyloccocus lugdenensis in PJI: Operative Management and Treatment Success

Authors Francis Sirch IV, Emanuele Chisari, Leanne Ludwick, Javad Parvizi

Background And Rationale Periprosthetic joint infections (PJI) is a leading cause of implant failure in total joint arthroplasty (TJA). Staphylococcus lugdunensis is a coagulase negative organism that has been increasingly identified as a causative pathogen causing PJI.

Study Question The purpose of this study was to evaluate the treatment success of two-stage exchange in patients with S.lugdunensis PJI and compare that with patients with Staphylococcus aureus PJI.

Methods We retrospectively reviewed the clinical records of all patients diagnosed with PJI, as defined by the 2018 International Consensus Meeting (ICM) criteria, at our institutions between 1999 and 2020. Patients with at least one positive culture for S. lugdunensis (SL), S. aureus (SA), and S. epidermidis (SE) were identified with at least 12-month follow up. Treatment success was defined according to 2019 MSIS criteria.

Results A total of 78 cases of PJIs managed with two-stage revision were identified with 48 SA, 14 SE, and 16 SL. There were no statistical differences between age, body mass index, or type of joint infected. Overall rate of treatment success was not significantly different between groups (SA 33 (68.8%) v SE 7 (50.0%) v SL 10 (62.5%) $p<0.391$). Bivariate regression analysis found no difference in failure between the groups.

Discussion S. Lugdunensis is gaining attention as a pathogen that can result in PJI. It appears that PJI caused by S. lugdunensis has a similar treatment success compared to PJI caused by other Staphlococcus species.

Conclusion The success of treatment of two-stage exchange needs to be improved as a relatively large number of patients with PJI experience subsequent failures of treatment.

853 Surgical Helmets Harbor Common Pathogens that Can Contaminate the Surgical Field

Authors Emanuele Chisari, Duncan Van Nest, Chad Krueger, Javad Parvizi

Background And Rationale Surgical helmet/hood systems are not routinely cleaned between cases. Thus, these helmets serve as a potential source of organisms spread to the patients.

Study Question Are surgical helmets worn by the surgical team carriers of pathogens that can ultimately increase the bioburden of an operative room and pose a risk for surgical field contamination and subsequent infection?

Methods This study is a prospective, observational study. Swab samples were obtained from the helmets and the forehead of surgeons using the hhelmets at three time points: prior to the first case, at the mid-point of the day between cases, and at the completion of the last case. Separate samples were taken from the forehead and surgical helmet of each individual. Samples were sent for culture and next generation sequencing (16S and ITS amplicon sequencing) for bacterial identification.

Results 28 individuals wearing the helmets were included, resulting in 84 samples taken from surgical helmets, and 84 corresponding samples taken from forehead. 73.8% of the samples taken from helmets isolated pathogen(s) at all time points, and 100% were positive for a pathogen at one point during the day. 82% of helmets demonstrated an increase in colony forming units on culture over the course of the day. 64% of helmets grew bacterial species from corresponding skin samples of the helmet user that were not present at the start of the day. The most common organisms were skin flora including C. acnes (56/84), Staphylococcus capitis (32/84), and Staphylococcus epidermidis (31/84). Significant pathogens of orthopaedic interest include coagulase negative staph (10/84), Enterococcus species (9/84), Enterobacter species (8/84), and Staphylococcus aureus (5/84), and Staphylococcus hominis (5/84).

Discussion Organisms that commonly cause orthopaedic infection are frequently identified on the surface of surgical helmets used during TJA.

Conclusion Amount of bacteria as well as number of species increase over the course of the operative day, suggesting a dynamic transfer between the skin of the helmet user and the surgical helmet.

852 Immune Response to Persistent Staphyloccocus aureus Periprostethic Joint Infection (PJI) in a Mouse Tibial Implant Model

Authors Upneet Sokhi, Yunwei Xia, Branden Sosa, Nirupama Nishtala, Tania Pannellini, Mathias Bostrom, Alberto Carli, Xu Yang, Lionel Ivashkiv

Background And Rationale PJI is a devastating complication of total joint arthroplasty and S. aureus is one of the major implicated pathogens. Why the adaptive immune system is ineffective in clearing this pathogen is not well understood. We tested the hypothesis that S. aureus induces exhaustion and tolerance of the immune system, which enables pathogen persistence and chronic infection. Using a clinically representative mouse model of PJI, we analyzed the immune response in joint and bone tissues and draining lymph nodes (LNs).

Study Question What is the role of the adaptive immune system in the persistent phase of PJI and what are the associated mechanisms involved in failure of bacterial clearance?

Methods A total of 66 C57BL/6 mice received a titanium tibial implant with or without an intra-articular injection of ~10^3 colony forming units of S. aureus (Xen36). Animals were euthanized over a time course of 3-35 days; blood, inguinal and iliac LNs, periarticular soft tissues, and knee joints were harvested for flow cytometry, RNA and histological analysis.

Results Acute phase response protein SAA increased at 7 dpi and remained elevated at 35 dpi. Histological analysis of knee joints and surrounding soft tissues revealed an acute inflammatory reaction characterized by PMN infiltration 3 dpi, progressing to massive inflammation, necrosis and granulomatous reactions in the soft tissue and bone 7 to 35 dpi. Joint and bone tissues exhibited elevated expression of innate immune cytokine and chemokine genes such as Il1b, Il6, Tnf, Il23a, Cxcl3 and Cxcl10 at 7 dpi that was sustained or increased by 35 dpi. Expression of T helper 1 (Th1) and Th17 effector and B cell marker genes progressively increased, while expression of regulatory T cell and CD8+ cytotoxic genes decreased. Draining LNs showed massive expansion at day 7 which was maintained at 35 dpi, with pronounced accumulation of both CD4+ and CD8+ T cells. CD8+ T cells in draining LNs exhibited increased expression of exhaustion markers.

Discussion In contrast to our predictions, persistent S. aureus PJI was associated with sustained and robust activation of multiple components of innate and adaptive immunity in joint and bone tissues and draining LNs. Understanding mechanisms by which S. aureus PJI persists in the face of a strong immune response deserves further study and may be relevant for chronic S. aureus PJI in human patients.

Conclusion Sustained activation of multiple innate and adaptive effector mechanisms is not sufficient to clear persistent S. aureus PJI.

851 Molecular Carriers for Local Delivery of Drugs without Systemic Elution of the Drug

Authors Gerhard Maale, Nicole Kennard, Aniruth Srinivasaraghavan, Arianna Mixon

Background And Rationale There is increasing interest in the use of molecular carriers for therapeutic drug delivery that is locally efficient and reduces risk of systemic toxicity. 100% pure synthetic calcium sulfate hemihydrate (PSCSH) pellets may be a suitable option for the local high dosing of drugs with controlled release. In this study, PSCSH pellets were impregnated with 240 mg tobramycin and 500 mg of vancomycin powder per 10 cc of the hemihydrate (PSCSH-TOB-VAN). Since PSCSH-TOB-VAN are soft upon hydration (hydrophilic), it does not scratch the cartilage in real or prosthetic joints. Local elution levels of antibiotics with PSCSH-TOB-VAN get to 100-1000 times MIC, without detectable serum levels. The purpose of this study was to observe the complications and side effects of PSCSH-TOB-VAN.

Study Question What complications do PSCSH-TOB-VAN present postoperatively?

Methods In our retrospective study, we evaluated 200 patients who were given PSCSH-TOB-VAN in both septic and aseptic one-stage revision arthroplasties for total hips and total knees. All patients had at least two year follow-up. We reviewed the volume of PSCSH-TOB-VAN used and recorded postop complications.

Results Of the 200 patients included in this study, 88 are male and 112 are female. The average age was 65 years with a range from 26 to 92 years. The average BMI of our patients was 31.7 and ranged from 12.8 to 67.5. 83 patients (42%) had PJI as their preoperative diagnosis. The average volume of PSCSH-TOB-VAN used was 23 mL, ranging from 20-60 mL depending on the size of the surgical defect. PSCSH-TOB-VAN disappeared on x-ray an average of 3 weeks postoperatively. 34% of patients had postoperative drainage. 13% of patients had heterotopic ossification around the joint. 14.5% of patients had reoperation: 15 recurrence of PJI, 4 recurrent dislocations, 2 had wound healing problems, 2 prosthetic failures, 2 periprosthetic fractures, 2 had multidirectional instability (MDI), 1 flap dehiscence, and 1 excision of painful heterotopic bone.

Discussion In our 200 patients, the pellets were completely absorbed by the tissues within 3 weeks of placement. None of our patients were subject to any systemic toxicity due to PSCSH-TOB-VAN, and complications were low (14.5% reoperation rate).

Conclusion PSCSH-TOB-VAN are biodegradable, soft, and cause minimal postop complications including wound drainage and heterotopic bone. With further studies, PSCSH could potentially provide high dosing of a variety of other local drug treatments.

850 EBJIS Definition for Periprosthetic Joint Infection: Questionable Accuracy

Authors Emanuele Chisari, Leanne Ludwick, Noam Shohat, Javad Parvizi

Background And Rationale Recently, the European Bone and Joint Infection Society (EBJIS) introduced a new definition for periprosthetic joint infection (PJI) that intends to improve on current diagnostic criteria proposed by the Musculoskeletal Infection Society (MSIS) and modified by the International Consensus Meeting (ICM). The intention of the EBJIS is to capture some of the “soft” cases of infection that MSIS/ICM misses. The EBJIS definition provides three potential scenarios: infection confirmed, infection likely, infection unlikely.

Study Question What is the EBJIS definition's performance (accuracy) in our PJI registry?

Methods Methods: This was a single-institution study on patients undergoing revision total joint arthroplasty between 2005 and 2020. To avoid selection bias, PJI cases were defined regardless of any published definition, as patients who underwent 2-stage revision surgery and who subsequently failed with reinfection within 1 year (n=80). Aseptic cases were defined as those who underwent one-stage revision for a non-infective indication and did not fail within 2 years (n = 166). Only patients with full data to meet each of the definitions were included. The performance of both criteria was examined and compared.

Results Among the 80 patients in the infected group, EBJIS criteria categorized 7 patients as “infection unlikely”, 5 patients as “infection likely”, and 68 patients (70%) patients as “infection confirmed”. The ICM criteria categorized 78 as positive and 2 as inconclusive. Among the aseptic cohort of 166 patients, 154 patients were negative per ICM criteria, 12 were categorized as inconclusive. According to EBJIS criteria, 12 categorized as “infection confirmed”, 11 as “infection likely” but none failed after a revision arthroplasty and no antibiotic treatment. The overall sensitivity and specificity were 91%, 86% for the EBJIS and 97.5 and 100% for the ICM, respectively.

Discussion The clinical utility of any diagnostic criteria is a balance between sensitivity and specificity. Higher sensitivity may lead to overdiagnosis and overtreatment. Because diagnosis of PJI usually leads to aggressive surgical procedures mandating the removal of well-fixed components and administration of prolonged systemic antibiotics, with all its untoward consequences, over-sensitive diagnostic criteria may lead to extensive patient morbidity.

Conclusion Based on its predictive value, using EBJIS definition would result in overtreatment 20-30% of patients presenting undergoing revision surgery. The EBJIS diagnostic criteria appear to over-diagnose and underdiagnose patients, leading us to conclude that it suffers a lower accuracy than MSIS/ICM diagnostic criteria.

849 Alpha-Defensin Does Not Provide Additional Benefit over Leukocyte Esterase in the Diagnosis Of Periprosthetic Joint Infection

Authors Emanuele Chisari, Noam Shohat, Steven Yacovell, Karan Goswami, Yajnesh Vedanaparti, Javad Parvizi

Background And Rationale Leukocyte esterase (LE) and α-defensin (AD) are two synovial biomarkers that are used for the diagnosis of periprosthetic joint infection (PJI), however the superiority of one over the other remains unknown.

Study Question How do Leukocyte Esterase and α-defensin differ in diagnostic value?

Methods In this retrospective study we evaluated patients who underwent revision total hip and knee arthroplasty at a single institution between 2013-2019 for whom both LE and AD were available. PJI was defined by the 2018 International Consensus Meeting criteria. The diagnostic performance of AD and LE were compared.

Results Overall 122 patients (28 PJI and 94 aseptic revisions) were included. The area under the curve (AUC) was 0.905 (95% confidence interval[CI]:0.820–0.991) and 0.913 [95%CI:0.834–0.992] for LE and AD respectively. Positive and negative predictive values were 95.8% (95%CI:76.5%-99.4%) and 94.9% (95%CI:89.4%-97.6%) for LE and 89.0% (95%CI:72.2%-96.1%) and 96.0% (95%CI:90.5%-98.3%) for AD. While both tests were useful in 18 cases that were inconclusive based on preoperative findings, AD had no benefit over LE.

Discussion Both LE and AD are valuable markers in patients with suspected PJI.

Conclusion Since LE is very inexpensive and readily available point-of-care test, we believe it offers more value in the work up of suspected PJI.

848 Next-generation Sequencing is Superior to PCR and Culture for Staphylococcus aureus Screening

Authors Emanuele Chisari, Leanne Ludwick, Karan Goswami, Javad Parvizi

Background And Rationale Multiple institutions have been using polymerase chain reaction (PCR) or culture to screen for methicillin resistant Staphylococcus aureus (MRSA) nasal colonization. It is believed that decolonization of MRSA may lower the risk for subsequent infection. Recent evidence suggests that decolonization of methicillin sensitive strains may also lower infection. However, both culture and PCR suffer some limitations related to sensitivity, turn around time, ability to distinguish between methicillin sensitive and resistant strains and so on.

Study Question Is next-generation sequencing (NGS), an innovative technique for pathogen identification, more accurate for Staph. screening?

Methods A prospective parallel superiority trial was designed. All patients undergoing hip and knee arthroplasty were considered eligible. Patients were screened during the pre-admission visit with a validated nasal swab. The swab was sent for culture or molecular diagnostics. The molecular testing consisted of PCR (targeted towards mecA to identify MRSA), NGS targeted the 16S rRNA sequence of the S. aureus genome. Statistical analysis consisted of descriptive statistics and a chi-squared test.

Results A total of 146 patients were consented and included in the study. Culture was positive for S. aureus in 16 patients. PCR, that targeted MRSA, was positive in one patient. NGS was able to identify S.aureus in 100% of culture positive cases and detected S. aureus genome in an additional 11 patients (total of 27). Additionally, NGS detected MRSA in one additional patient. Overall, NGS outperformed culture and PCR in detecting S.aureus, including MRSA.

Discussion This prospective ongoing study reveals that next-generation sequencing outperforms culture and PCR for detection of S. aureus colonization of nares in patients undergoing total joint arthroplasty.

Conclusion Although NGS is offered at low prices, its economic feasibility should be explored to determine whether the increased cost of this technology is justified.

847 Is Manually Mixed Povidone Iodine Irrigation Preparation Reliable?

Authors Emanuele Chisari, Noam Shohat, Karan Goswami, Chad Krueger, Javad Parvizi, Edward Schwarz

Background And Rationale One of the measures to decrease the risk of surgical site infections in orthopaedics, namely periprosthetic joint infections (PJI), is povidone-iodine (PVP-I) surgical irrigation. Multiple reports have shown that PVP-I solution can lose bactericidal effects if too diluted, therefore its concentration is critical to affect viable organisms in the surgical field.

Study Question What is the percentage of the active portion of PVP-I (available iodine) when manually mixed in the OR before irrigating the field?

Methods Manually mixed PVP-I solution were retrieved from the 2 operating rooms of a single surgeon at the same institution (n=15). Staff did not differ throughout the weeks of enrollment. A packet of 10mL of sterile PVP-I 10% w/v solution was poured in 1L of sterile saline solution. The solution target is 0.2% of PVP-I per standard of care at our institution. Samples were collected with aseptic technique at the time of preparation after 10 second of stirring. All the samples were then transported to the lab in a 30 min window to be tested for available iodine percentage, using a validated indirect measurement through titration using sodium thiosulphate.

Results The mean PVP-I concentration retrieved was 0.12% ± 0.06%. Only one sample met the expected PVP-I concentration (0.2%). After collection and stirring, macroscopic assessment of the PVP-I solution showed PVP-I to precipitate on the bottom of the basin after about 30-45 seconds.

Discussion Manually mixed PVP-I irrigation solutions are not consistent in the percentage of active PVP-I in the solution.

Conclusion This inconsistency can affect the result of their use in clinical practice and should be further investigated.

846 The First-Year Experience of a Regional Referral Center for Periprosthetic Joint Infections

Authors Murillo Adrados, Michael Valenzuela, Gregory Scarola, Thomas Fehring, Jesse Otero

Background And Rationale Many medical fields have found quality benefits from volume thresholds. We inferred that we could similarly optimize periprosthetic joint infection (PJI) treatment by creating a regional referral center, concentrating the care of this time-consuming and resource intensive issue to one center. Expertise of both infectious disease and arthroplasty-trained physicians, along with standardized protocols across all settings, can provide referred patients with service dedicated to the treatment of PJI.

We began advertising our PJI Center in July 2019 and sent bulletins explaining the goals of the project and method of referral. In this study we reviewed our cases and give a summary of our first year experience.

Study Question What is the volume of infection surgery performed in one year at the PJI center?

What is the patient demographic and comorbidity profile?

How far do patients travel for care?

How often was work-up complete prior to referral?

Methods We selected all patients at our institution who underwent PJI surgery of the hip or knee from 8/1/2019—7/31/2020. We retrospectively reviewed all charts for demographic information including age, sex, BMI, and McPherson classification of infection, host, and extremity. Other information reviewed included infection procedure, offending organism, and referral information, including distance traveled by the patient, source of referral, and PJI work-up completed upon referral (ESR, CRP, joint aspirate, cell count and differential, culture performed).

Results We identified 298 PJI related surgeries in 212 patients in the first year of our center. We treated 142 knee and 70 hip PJIs. Gram-positive bacteria caused most infections, accounting for 81% of knee infections and 82.9% of hip infections. MSSA was identified in 26.1% of knees and 30% of hips. MRSA was identified in 19% of knees and 28.6% of hips. Referred patients traveled an average of 57.1 miles (IQR 25.5, 117.9). Only 42.9% of outpatient referrals had complete work up at time of referral (ESR, CRP, joint aspirate with cell count and culture).

Discussion We successfully established a referral center for PJI. We expect that the concentration on high PJI volume improve care of referred patients. This system has the added benefit in concentrating cases for future research and trials.

Conclusion Our PJI center encountered a high volume of referrals from the surrounding region, which may aid in enhanced treatment of PJI.

845 Bacterial Tropism affects the Success of DAIR for the Treatment of Periprosthetic Joint Infections? A Systematic Review and Metanalysis

Authors Emanuele Chisari, Leanne Ludwick, Jasmine Wang, Edward Schwarz, Javad Parvizi

Background And Rationale Previous studies have showed that the pathophysiology of staphylococcus aureus periprosthetic joint infections (StaphA-PJI) differ from the Streptococcus agalactiae PJI (StreptA-PJI).

Study Question The purpose of this systematic review is to investigate whether the success rate of Debridement, Antibiotics, and Implant Retention (DAIR) differ between these two bacterial PJI.

Methods A systematic review was performed searching PubMed, Embase, and Cochrane Library databases following the PRISMA guidelines. We included studies of any level of evidence published in peer-reviewed journals. The risk of bias was assessed, as was the methodological quality of the included studies. We excluded all the articles with a high risk of bias and/or low quality after the assessment.

Results After the final selection, 25 studies for a total of 2,415 PJI individual patients were included in the present systematic review. All studies were retrospective observational cohort studies analyzing the success of DAIR procedures for the treatment of PJI. StaphA-PJI was present in 1,807 individual patients, while 608 were affected by StrepA-PJI. Studies ranged from 2008 to 2020 as per year of publication. Patients affected by StaphA-PJI have a 1.55 fold increase in the risk of failure of a DAIR procedure (OR 1.55 [1.27; 1.89]).

Discussion The distinct pathogenesis of StaphA-PJI and StreptA-PJI has relevant and sound clinical consequences.

Conclusion We hereby report that the vasculotropic pathogenesis of StrepA-PJI makes them an ideal candidate for DAIR.

844 PJI Could be Result of Damage to Gut Epithelial Barrier

Authors Emanuele Chisari, Karan Goswami, Javad Parvizi

Background And Rationale A growing number of recent investigations on the human genome, gut microbiome, and proteomics suggests that the loss of mucosal barrier function, particularly in the gastrointestinal tract, may substantially affect antigen trafficking, ultimately influencing the close bidirectional interaction between the gut microbiome and the immune system. This cross-talk is highly influential in shaping the host immune system function and ultimately shifting genetic predisposition to clinical outcome.

Study Question We hypothesized that a similar interaction could affect the occurrence of acute and chronic periprosthetic joint infections (PJI).

Methods Multiple biomarkers of gut barrier disruption were tested in parallel in plasma samples collected as part of a prospective cohort study of patients undergoing revision arthroplasty for aseptic or PJI (As defined by the 2018 ICM criteria). All blood samples were collected before any antibiotic was administered. Samples were tested for Zonulin, soluble CD14 (sCD14), and lipopolysaccharide (LPS) using commercially available enzyme-linked immunosorbent assays. Statistical analysis consisted of descriptive statistics and ANOVA.

Results A total of 96 patients were consented and included in the study. 32 were classified as PJI (23 chronic and 9 acute), and 64 as aseptic. Both Zonulin and LPS were increased in the acute PJI group 8.448 ± 7.726 ng/mL and 4.106 ± 4.260 u/mL, compared to chronic PJI and aseptic revisions. sCD14 was found to be increased in both chronic (0.463 ± 0.168 ug/mL) and acute PJI (0.463 ± 0.389 ug/mL) compared to aseptic revisions.

Discussion This prospective ongoing study reveals a possible link between gut permeability and the ‘gut-immune-joint axis’ in PJI. If this association continues to be born out with larger cohort recruitment, it would have a massive implication in managing patients with PJI.

Conclusion In addition to the administration of antimicrobials, patients with PJI and other orthopedic infections may require gastrointestinal modulators such as pro and prebiotics.

843 Biofilm Eradication: What's New in Biofilm Disruption Strategies for Prosthetic Joint Infection

Authors Anabelle Visperas, Daniel Santana, Alison Klika, Carlos Higuera-Rueda, Nicolas Piuzzi

Background And Rationale Periprosthetic joint infection (PJI) is a devastating complication of total joint arthroplasty. Bacteria involved in these infections are notorious for adhering to foreign implanted surfaces by generating a biofilm matrix. These biofilms protect the bacteria from antibiotic treatment and the immune system making eradication difficult. Current treatment strategies including debridement, antibiotics, and implant retention (DAIR) and one- and two-stage revisions still have a relatively high failure rate suggesting that these treatments are suboptimal to combat infections where biofilms are involved.

Study Question Are there new strategies that target biofilm disruption that have the potential for PJI treatment?

Methods A literature search was conducted using PubMed from 1999-2020 to identify reports on methods used in in vitro, ex vivo, and in vivo biofilm disruption animal models using orthopaedic relevant bacteria or in clinical studies.

Results Electrochemical therapy has shown promise mainly in vitro where the production of either oxidative or reducing states affect both biofilm and bacteria survival. Use of small molecule (cAMP, cGMP) inhibition has the potential to hinder the maturation process or mature biofilm infections. Levels of endogenous anti-bacteria antibodies or use of anti-bacteria antisera have shown correlation with better infection outcomes. Indeed, synthetic antimicrobial peptides have shown efficacy as an anti-biofilm treatment both in vitro and in vivo in a rat jugular vein catheter infection model. Many studies have targeted membrane components including polysaccharides and eDNA via use of enzymes, oxidizing agents, and endogenous membrane breakdown products with various levels of anti-biofilm success. Finally, use of endogenous inhibitors from other bacteria and viruses have some promising results, where bacteriophages have been used in humans with variable success. Of note, phages are specific to bacterial strain where strain identity is required. Nevertheless, many of these biofilm eradication methods are more productive in both anti-biofilm and bactericidal effects when combined with antibiotic therapy (Table 1).

Discussion Multiple strategies have the potential to combat PJI by targeting biofilm integrity, therefore giving antibiotics and the immune system access to the internal network of the biofilm structure.

Conclusion Combination of anti-biofilm/antibiotic therapy can be developed for novel PJI treatment strategies.

Table 1. Summary of anti-biofilm methods

Type	Method	Mechanism	Pre-Clinical Testing *In vitro*	Pre-Clinical Testing *Ex vivo*	Pre-Clinical Testing *In vivo*	Clinical Testing	Antibiotics better outcomes
Electrochemical	CVCES	Alkaline pH	X		X		X
	E-scaffolds	H_2O_2/HoCl production	X	X			
	Electrical Currents	Alkaline pH	X				
	Hyperthermia	Bacterial release	X				
Small Molecule	c-di-GMP	Complex and sequestration	X				
	c-di-AMP	Extrinsic	X				
	Nitric Oxide	Biofilm Dispersal	X				X
Antibodies	Anti-DNABII	Sequestration	X		X		
	TRL1068	Sequestration	X		X		X
	Anti-Atl	Phagocytosis by macrophages		X	X		
Antimicrobial Peptides	LL-37	Unknown			X		
	D-Bac8c	Unknown			X		
	1018-K6	Cell membrane breakdown	X				
	pepR	Unknown	X				
Targeting Polysaccharides	Dispersin B	PNAG hydrolyzing activity	X				
	Periodate	Breakdown with I & O	X				
	Proteinase K	Amyloid fiber breakdown	X	X			X
	D-amino acids	Amyloid fiber breakdown	X				
Targeting eDNA	DNase I	DNA degradation	X		X	X	X
	NucB	DNA degradation	X	X			
Bacterial/Viral products	Esp	Serine protease (*S. epidermidis*)	X				
	Unidentified molecule	Secreted molecule (*S. epidermidis*)	X				
	Bacteriophages	Infects & lyse bacteria	X		X	X	X

842 Metal-on-Polyethylene Implants Associated with Higher Risk of PJI versus Ceramic-on-Polyethylene

Authors Emanuele, Chisari, Christian Ong, Noam Shohat, Javad Parvizi, Chad Krueger

Background And Rationale Metal-on-polyethylene (MoP) total hip arthroplasty prostheses are known to release metal debris. Emerging preclinical evidence suggest that metal implants induce a pro-inflammatory response that ultimately chemoattracts leukocytes to the surgical site. Leukocyte recruitment raises concern of higher risk of infection through the “trojan horse” mechanism (leukocytes phagocytose pathogens at a remote site lead to chemotaxis due to the cytokine gradient concentrate leucocytes at the surgical site).

Study Question What is the difference in the infection occurrence between MoP and ceramic-on-poliethylene (CoP) implants?

Methods With an alpha of 0.05, a beta of 0.2, an expected 60% increase in the incidence of PJI associated with MoP, we estimated the need for 11,000 patients for this study. We reviewed a consecutive series of 6,234 CoP and 4,775 MoP primary total hip arthroplasty patients from 2015 to 2019. The occurrence of periprosthetic joint infection at two years was defined according to the 2018 ICM definition. Statistical analysis consisted of descriptive statistics and multivariate logistic regression modelling.

Results When compared to CoP patients, MoP patients were older, with an higher body mass index and more commonly affected by comorbidities according to Elixhauser score. The absolute incidence of PJI was higher in MoP patients (2.40% vs 1.64%). When we adjusted for confounding factors in a multivariate analysis, the use of MoP was found independently associated with an higher risk of PJI (effect size 0.34, OR 1.75) as a result of a medium-to-small effect size.

Discussion We found a higher incidence of PJI in the patients were MoP was preferred. While many confounding could affect bivariate analysis, a medium significant effect was observed in a multivariate model.

Conclusion While the design of the study does not allow for causal inference, the author hypothesize that the leucocyte recruitment of these implants and PJI should be studied further.

841 Repeated 2-stage arthroplasty to treat a failed 2-stage revision for periprosthetic hip or knee infection: A tertiary center experience

Authors Tejbir Pannu , Alison Klika, Jesus Villa, Ardalan Sayan, Carlos Higuera, Aldo Riesgo

Background And Rationale Persistent periprosthetic joint infection (PJI) after 2-stage revision ranges widely from 0 to 40%, and in many instances, another 2-stage is the chosen procedure. However, literature is still scarce on the outcomes of this repeated surgical undertaking as compared to the first 2-stage.

Study Question To determine and compare the outcomes between a repeated 2-stage (second or third) and first 2-stage revision for treatment of PJI.

Methods A retrospective review was conducted on a consecutive series of 1015 revision total hip and knee arthroplasties, which were performed by 9 surgeons (2009-2020) at a single institution. After comprehensive review of the operative notes, 107 2-stage revisions were identified. The inclusion criteria were the completion of reimplantation and minimum follow-up of 1 year. Of 107, 95 2-stage revisions which met these criteria were finally included. Two-stage revisions were grouped as: first 2-stage (n=82) and repeated (second, n=12 and third, n=1) 2-stage (n=13). Demographic and surgical characteristics (mean operative time, blood transfusion requirements, length of hospital stay; emergency department (ED) visits) were compared between these 2 groups. Treatment success was defined by MSIS outcome-reporting tool at minimum 1-year follow up and collected as: Tier 1 (infection control with no continued antibiotics), Tier 2 (infection control with suppressive antibiotics), Tier 3 (A to F; need for reoperation or spacer retention), and Tier 4 (A; B; death). Independent t-tests and chi-square tests were conducted. The statistical significance was set at p-value<0.05.

Results The mean follow-up for all 2-stage revisions was 29.8±139.6 months. On comparing repeated and first 2-stage revisions, no significant differences were found in mean operative time (p=0.057), transfusion requirements (p=0.207), and length of hospital stay (p=0.199). While repeated 2-stage patients visited ED more frequently (vs first 2-stage; p=0.002) within 90 days of surgery, there was no difference in reoperation rate, readmission rate and MSIS Tier (1/2 vs 3/4) outcomes between patients who underwent repeated and first 2-stage revision (Table 1).

Discussion This data suggests that repeated 2-stage revision results in outcomes comparable to the first 2-stage revision at minimum1-year.

Conclusion In the setting of persistent PJI, it seems worthwhile to repeat 2-stage with no additional risk of adverse outcomes as compared to the first 2-stage revision.

Table 1. Comparison of outcomes between a repeated 2-stage (second or third) and first 2-stage revisions for treatment of periprosthetic joint infection.

Characteristic	First 2-Stage (n=82)	Repeated 2-Stage (n=13)	p-value
Mean Operative Time (min)	226.4±65.8	197.2±44.6	0.057
Length of Hospital Stay	3.8±2.6	5.8±5.2	0.199
Hospital Transfusion	24(32%)	7(53.8%)	0.207
ED Visits within 90days	9(12%)	7(53.8%)	**0.002**
Reoperation within 90days	13 (15.9%)	4(30.8%)	0.240
Readmission within 90days	13(15.9%)	5(38.5%)	0.067
Reoperation at minimum 1 year	29(35.4%)	5(38.5%)	1.000
Readmission at minimum 1 year	29(35.4%)	5(38.5%)	1.000
MSIS Outcome Reporting Tool (minimum 1-year follow-up)			
Tier 1 and 2	50(61%)	7(53.8%)	0.762
Tier 3 (A,B,C,D,E,F) and 4 (A,B)	32(39%)	6(46.2%)	
ED: Emergency department; ± Standard Deviation; Significance set at p-value <0.05			

840 Killing of a Multispecies Biofilm Using a Gram-Negative and Gram-Positive Targeted Antibiotic

Authors Kelly Moore, Anthony Li, Craig Delury, Phillip Laycock, Sean Aiken, Paul Stoodley

Background And Rationale Multispecies biofilms are becoming more prevalent in periprosthetic joint infections (PJI). The interspecies interactions make these infections more complex to manage. Treatment of Gram positive and negative mixed species biofilms such as Pseudomonas aeruginosa (PA) and Enterococcus faecalis (EF) or Staphylococcus aureus (SA) and Enterobacter cloacae (EC) are even more challenging.

Study Question In this study, we looked to determine if we could generate and kill multispecies in-vitro biofilms consisting of a Gram-negative and positive pathogen by challenging them with an antibiotic loaded calcium sulfate bead containing single or combination antibiotics.

Methods Stainless steel coupons were inoculated with a). PA and EF or b). SA and EC to determine if the species would grow together. Thereafter, 24h agar lawn multispecies biofilms of PA and EF, and SA and EC, were grown and challenged with calcium sulfate beads loaded (Stimulan Rapid Cure) with a). vancomycin, b). tobramycin or c). vancomycin and tobramycin. Bioluminescence and light images were used to assess metabolic activity and growth of non-bioluminescent strains. Replica plating was used to assess viability.

Results PA and EF, and SA and EC, both grew in similar concentrations when inoculated together on stainless steel coupons. When challenged with a vancomycin-loaded bead, only EF and SA were killed, leaving PA and EC biofilms. Moreover, when challenged with a tobramycin-loaded bead, a zone of killing was generated in both multispecies biofilms, however, this zone was smaller and included more tolerant variants than the zone generated by calcium sulfate beads containing combinations of vancomycin and tobramycin.

Discussion Variants of PA and SA were significantly reduced when using the vancomycin and tobramycin combination compared to either antibiotic alone.

Conclusion A calcium sulfate bead containing a broad spectrum and Gram-positive targeted antibiotic killed a larger percentage of a multispecies in-vitro biofilm than either single gram-specific antibiotic alone.

839 Excellent outcome of oral antibiotics for selected patients with bone and joint infection: real-world experience from implementing OVIVA

Authors Jacey Hilbers, Nicolas Cortes-Penfield, Amanda Lang, Mason Halouska, Zachary VanRoy, Angela Hewlett

Background And Rationale Recently, the OVIVA trial challenged the traditional preference for long-term IV vs oral therapy in bone and joint infection. We report our initial experience adopting oral antibiotic therapy in this setting.

Study Question Can we achieve good clinical outcomes in patients with bone and joint infections treated primarily with oral antibiotics?

Methods Medical records were abstracted for patients >18 years old with osteomyelitis, native or prosthetic joint infection, or other orthopedic hardware infection who were seen in the orthopedic infectious disease clinic within a 6-month period. Only patients who received surgery plus at least two weeks of antimicrobial therapy and had no prior treatment failure of an infection at the same site were included. Data regarding demographics, comorbidities, treating physicians, infection type, anatomic site, pathogens, surgical management, and antibiotic management was recorded. The primary outcome was treatment failure at one year, defined as death, unplanned surgery at the same anatomic site, or initiation of chronic antibiotic suppression.

Results Forty patients were included (all IV, n=17; initial or switch to orals, n=23 with median 15 days to switch to orals). Prosthetic joint infection (n=22) was most common, followed by osteomyelitis and other hardware infections (n=7 each); infected hardware was retained in 9 cases and explanted in 20. Patients switched to oral antibiotics were younger (55 vs. 66 years), more often male (70% vs. 59%), were less likely to have major comorbidities (30% vs. 47%), and had lower BMI (mean 30.3 vs 33.3). Six treatment failures occurred in the all-IV treatment group (35%) and none in the group treated with initial or switch to orals group. The most common reasons for treatment failure were chronic antibiotic suppression (n=5) and unplanned surgery (n=3).

Discussion Our orthopedic ID group uses early oral antibiotics in patients with bone and joint infection due to pathogens susceptible to highly bioavailable agents who have no history of treatment failure and low perceived risk for poor medication adherence. Our results indicate that these criteria reliably identify patients who are likely to do well with oral antibiotics across a range of infection types, pathogens, and surgical approaches.

Conclusion Oral antibiotic treatment for bone and joint infection can be highly effective in selected patients.

838 Higher Risk of Acute Kidney Injury in Two-Stage versus One-Stage Revision for Periprosthetic Joint Infection: A Randomized Prospective Trial

Authors Michael Valenzuela, Jesse E Otero, Susan Odum, Bryan Springer, Thomas Fehring

Background And Rationale Standard treatment for periprosthetic joint infection (PJI) involves two-stage exchange arthroplasty, which uses placement of an antibiotic cement spacer (ACS). Conflicting evidence exists on the role of ACS in development of acute kidney injury (AKI) after first-stage surgery. We aimed to compare the incidence of AKI between the first-stage of a planned two-stage exchange versus one-stage exchange, which lacks use of an ACS.

Study Question Is there a difference in incidence of AKI in patients who undergo one-stage versus two-stage exchange with antibiotic cement spacer placement? What are the risk factors that influence the development of AKI in patients who undergo one- or two-stage revision for PJI?

Methods The study is a randomized clinical trial comparing 1- vs 2-stage exchange treatments for PJI. 104 patients were randomized to receive either 1- or 2-stage exchange. The primary outcome variable was AKI, defined as a creatinine ≥ 1.5 times baseline or an increase of ≥0.3 mg/dL. Risk factors for AKI were evaluated using bivariate statistical tests and multivariable logistic regression.

Results Two patients did not have a postoperative creatinine within 48 hours and were withdrawn, leaving 102 patients included for final analysis. 52 patients received 2-stage exchange; 50 patients received 1-stage exchange. Patients who underwent the first stage of a planned 2-stage exchange were significantly more likely to develop AKI compared with the 1-stage exchange group, [20(38.5%) vs. 5(10%), p=0.0008]. On multivariable regression analysis, ACS placement was an independent predictor for AKI [Odds Ratio=4.9(1.6-15.5), p=0.0067], but chronic kidney disease, Macpherson host type, operative time, and intraoperative anesthesia events were not.

Discussion The two study groups received identical treatment, only differing by use of the ACS, suggesting ACS placement directly contributes to development of AKI. As we found no other risk factors that significantly contributed to development of AKI, future studies are needed to assess the true influence of these factors.

Conclusion Our study provides evidence that use of antibiotic cement spacers for the treatment of PJI is independently associated with AKI. We failed to find other independent predictors of AKI. With regard to the risk of AKI, one-stage treatment for PJI may be a safer alternative.

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837 Methicillin Resistant Staphylococcus aureus is not Always Resistant to Cefazolin

Authors Alex Cappellini, Kimberly Brothers, Kenneth Urish

Background And Rationale Antibiotic resistant organisms are a challenge in orthopaedic infection, and an excellent example includes Methicillin Resistant Staphylococcus aureus (MRSA) [1,2]. Vancomycin is the antibiotic of choice in these infections [4]. Multiple clinical studies have noted that in MRSA sepsis combination therapy with vancomycin and cefazolin has improved clinical outcomes as compared to vancomycin alone. The objective of this study was to determine if combination therapy with cefazolin and vancomycin in MRSA has utility in orthopaedic infections. We hypothesized that MRSA resistance to cefazolin would be altered as a function of different culture mediums.

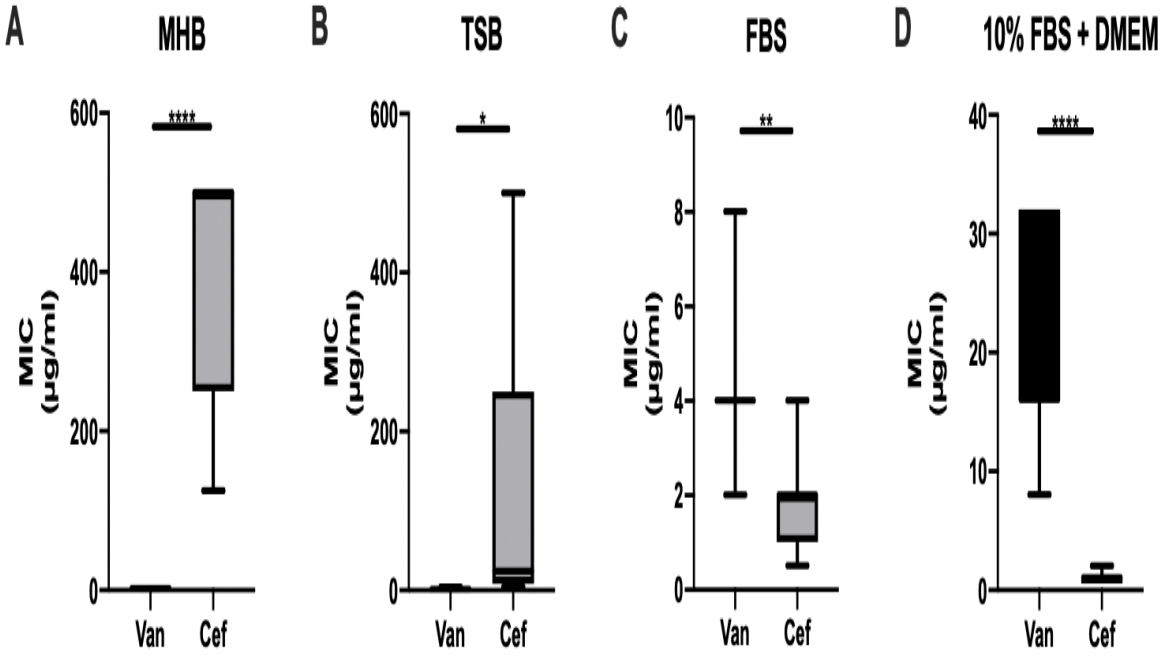
Study Question Can the apparent expression of the mecA gene and resistance to cefazolin be suppressed by altering the culture medium?

Methods S. aureus strains JE2, SH1000, as well as 9 MRSA clinical isolates were tested. IRB approval was obtained (PRO15070263). The minimum inhibitory concentration (MIC) of planktonic MRSA was determined using standard Clinical and Laboratory Standards Institute (CLSI) protocols. Each strain was separately grown in 4 different media types (Mueller Hinton Broth (MHB), Tryptic Soy Broth (TSB), Fetal Bovine Serum (FBS), and 10% FBS + Dulbecco's Modified Eagles Medium (10% FBS + DMEM)). Serial dilutions of vancomycin and cefazolin were tested for each strain background in each media type in triplicate. CLSI protocols consisted of inoculating each strain from -80oC storage, by growing in 5 ml of media for 24 hours at 37oC. Optical density of cultures were normalized to 0.5x106 CFU/ml using a 0.5 McFarland standard. Antibiotic fold dilutions were prepared in 96 well plates with concentrations ranging from 0 to 500 μg/ml.

Results MICs were quantified using CLSI protocol. In MHB, the MICs were between 1 and 2 μg/ml for vancomycin and between 125 and 500 μg/ml for cefazolin (Fig. 1A; $p<0.05$). In TSB the MICs were between 0.5 and 4 μg/ml for vancomycin and 4 to 500 μg/ml for cefazolin (Fig. 1B; $p=0.0268$). In FBS the MICs were between 2 and 8 μg/ml for vancomycin and between 0.5 and 4 μg/ml for cefazolin (Fig. 2C; $p<0.05$). Finally, for 10% FBS + DMEM the MICs were between 8 and 32 μg/ml for vancomycin and 0.5 and 2 μg/ml for cefazolin (Fig. 1D; $p<0.05$).

Discussion In MRSA, the mecA gene is responsible for resistance to beta-lactam antibiotics, including cefazolin [3]. Vancomycin is the typical antibiotic of choice in MRSA infections, but has its disadvantages as vancomycin has decreased bioavailability as compared to cefazolin [4]. The presence of mecA gene does not guarantee its expression in MRSA infections. The purpose of this study was to test changes in resistance to cefazolin in MRSA in more physiologically relevant culture media as compared to standard media used in the laboratory. Resistance to the beta-lactam antibiotic cefazolin was seen in the different media types. In MHB, the standard culture media for determining MIC, all of the MRSA strains tested were resistant to cefazolin as expected. This indicates expression of the mecA gene in this culture medium. Surprisingly, more physiologically relevant media containing serum resulted in a statistically significant decrease in cefazolin sensitivity so that MRSA MIC of cefazolin was lower than that of vancomycin ($p<0.05$). This indicates a low level of expression of the mecA gene. Although all strains possessed the mecA gene as demonstrated by culture in MHB, expression of the mecA gene to confer resistance to cefazolin was variable based on culture conditions. Infections caused by Staphylococcus aureus effect around 120,000 US citizens every year. Around 50% of these infections are from MRSA [3,5]. Infections caused by MRSA rather than MSSA have a higher death rate at approximately 10% [1]. A better understanding in how to treat MRSA can increase the number of positive clinical outcomes……..

Figure 1: MIC for planktonically grown MRSA in A) MHB, B) TSB, C) FBS, and D) 10% FBS + DMEM treated with Vancomycin and Cefazolin *p<0.1 **p<0.01 ****p<0.0001



826 Malnutrition Predicts Failure of Two-Stage Exchange for Chronic Periprosthetic Joint Infection

Authors Cody C Green, Michael Valenzuela, Taylor Rowe, Susan Odum, Thomas Fehring, Jesse Otero

Background And Rationale It is well-known that nutritionally-compromised patients, shown by low preoperative serum albumin (SAB) or total lymphocyte count (TLC), portends a higher risk for periprosthetic joint infection (PJI) in primary total joint arthroplasty (TJA). However, the relationship between nutritional status and treatment success of PJI is unknown. We aimed to study the relationship between pre-resection nutrition status and success after first-stage resection in planned two-stage exchange for PJI.

Study Question Is hypoalbuminemia (albumin<3.5g/dL) or low TLC (<1,500 cells/mm3) associated with failure to cure infection after first-stage resection for chronic hip or knee PJI?

Methods A retrospective review was performed on all patients who had first-stage resection as a part of a planned two-stage exchange for chronic PJI between January 2014 and December 2018. Patients were included who completed first stage, had available pre-op SAB or TLC, and had 2-year follow-up. Failure was defined as persistent infection or repeat surgery for infection after first-stage resection. Demographic and surgical data were collected and analyzed.

Results From 2014 to 2018, 293 1st stage procedures were performed, with 168 patients meeting inclusion criteria. Thirty-nine patients had normal nutrition, and 129 patients were in the low SAB and/or low TLC group. Patients with pre-op SAB >3.5 g/dL had a 26% failure rate versus a 46% failure rate when SAB <3.5 g/dL (p=0.011). Low SAB had an odds ratio (OR) of 2.4 for failure risk compared to normal SAB (p=0.01). No difference in failure rate was noted in the low versus normal TLC groups(p=0.70). MSIS Host type was also associated with risk of failure (p=0.007), with Type C hosts having an OR of 3.8 for failure compared to Type A host (p=0.01).

Discussion Our study shows that low preoperative SAB is associated with increased risk of failure after first stage resection in planned two-stage exchange for PJI. MSIS Host type-C was also associated with failure. While PJI eradication is likely multifactorial, low SAB and poor host grade are associated with immune dysfunction.

Conclusion Preoperative hypoalbuminemia was associated with treatment failure following first-stage resection for PJI. Efforts to nutritionally optimize PJI patients, when possible, may improve the outcome of two-stage exchange.

835 Bacteriophage is More Effective in Treating MRSA Biofilm on Plasma Spray Titanium Surface Compared to Vancomycin

Authors Mariam Taha, Hesham Abdelbary

Background And Rationale Failure rate of standard treatment for Periprosthetic joint infection (PJI)is estimated to be around 40% at two years post revision surgery. A major clinical challenge contributing to treatment failure and antibiotics tolerance is the biofilm formation on implant surfaces. Lytic bacteriophages (phages) can target biofilm associated bacteria at localized sites of infection by penetrating and disrupting biofilm matrices; furthermore, phage replication within the biofilm leads to high local concentrations resulting in a powerful therapeutic effect.

Study Question The aim of this study is to test if phage has better antimicrobial effect than vancomycin alone against premature (intra-operative contamination) and mature (established PJI) Staphylococcus aureus biofilms on titanium implant surface.

Methods S. aureus BP043 was utilized in this study. This strain is a PJI clinical isolate, methicillin resistant (MRSA) and biofilm-former. Phage Remus, a lytic phage known to infect S. aureus, was used. S. aureus BP043 was grown as planktonic culture in 96-well plate or as biofilm at 3hr (premature biofilm) or 24hr (mature biofilm) on plasma sprayed titanium (Ti-6Al-4V) alloy disc surfaces. Planktonic cells were adjusted to ~ 1x10^9 CFU/mL in tryptic soy broth (TSB) and phage was added at about 1x10^9 PFU/mL with moi of 1 (a multiplicity of infection). Bacterial growth was assessed by measuring optical densities at 24hr and was compared to the control of S. aureus BP043 with no phage. Already established premature or mature biofilms were treated with phage at about 1x10^9 PFU/mL or with vancomycin at 500 ug/mL (sub- minimal biofilm eradication concentration) for 24hr in TSB at 37oC. Then, discs were sonicated and vortexed to dislodge bacteria. Bacterial survival was assessed by plating on tryptic soy agar plates. Survival in treated biofilms was compared to control biofilm that was exposed only to TSB.

Results Planktonic cells growth in the presence of phage Remus was reduced significantly ($p < 0.0001$) after 24hr compared to the control with no phage. Exposing BP043 biofilm to the phage Remus resulted in more than 95% and 65% reduction in bacteria residing in the premature and mature biofilms, respectively. Vancomycin showed lower efficacy compared to the phage where there was a reduction of about 53% in premature biofilm and about 13% in mature biofilm cultures. Each experiment was repeated at least twice.

Discussion We have demonstrated that the usage of lytic phage contributes to better clearance of planktonic cultures of the S. aureus MRSA isolate. More importantly, viable bacteria in the mature biofilms that were grown on plasma sprayed titanium discs and treated with phage were reduced 5 more times compared to using vancomycin alone.

Conclusion This work is aimed at gathering preclinical evidence for using phage as a new therapeutic avenue to treat PJI.

834 PhotothermAA gel decreases biofilm burden in a rabbit model of Periprosthetic Joint Infection

Authors Anabelle Visperas, Daniel Santana, Minseon Ju, Nathalie Milbrandt, Yu Hsin Tsai, Nicolas Puzzi, Alison Klika, Anna Cristina Samia, Carlos Higuera-Rueda

Background And Rationale Periprosthetic joint infection (PJI) is a devastating complication of total joint arthroplasty. Bacteria is protected from antibiotics and the immune system by a biofilm matrix making eradication using current treatment strategies difficult. PhotothermAA gel is a combination of two methods that has been shown in vitro to disrupt biofilm – D-amino acids and hyperthermia via gold nanoparticles heated using a laser. These components are introduced to the site in a hydrogel that gelatinizes at body temperature for targeted treatment.

Study Question Can PhotothermAA gel eradicate bacterial biofilm in a rabbit model of PJI?

Methods Rabbits were fitted with a titanium implant into the tibial plateau and inoculated with 5x10^6 CFU Xen36 (luminescent Staphylococcus aureus). At two weeks, rabbits underwent irrigation and debridement and treatment with PhotothermAA gel for two hours and subsequently laser heated using an 808 nm laser for 10 minutes. Gel was washed out and implant was removed for biofilm coverage analysis via scanning electron microscopy (SEM). Periprosthetic tissue was collected before and after treatment for toxicity studies via hemotoxylin and eosin (H&E) staining and scored for necrosis by three blinded reviewers.

Results Implants isolated after PhotothermAA gel treatment had significantly less biofilm coverage on the surface of the implant compared to non-treated control ($p < 0.014$; Figure 1A). PhotothermAA gel treatment and subsequent laser treatment was not harmful to surrounding tissue as no increase in necrotic tissue was observed (Figure 2B).

Discussion While a significant decrease was observed immediately after PhotothermAA gel and laser treatment, whether this decrease is substantial enough to decrease infection outcomes including cultures, C-reactive protein (CRP), and histology over time still needs to be determined. Also, whether combination treatment with antibiotics will further decrease biofilm coverage and bacterial burden will be tested in future studies. Nevertheless, PhotothermAA gel and laser treatment is non-toxic to periprosthetic tissue.

Conclusion PhotothermAA gel and laser treatment safely decreases biofilm coverage on infected knee implants in a rabbit PJI model.

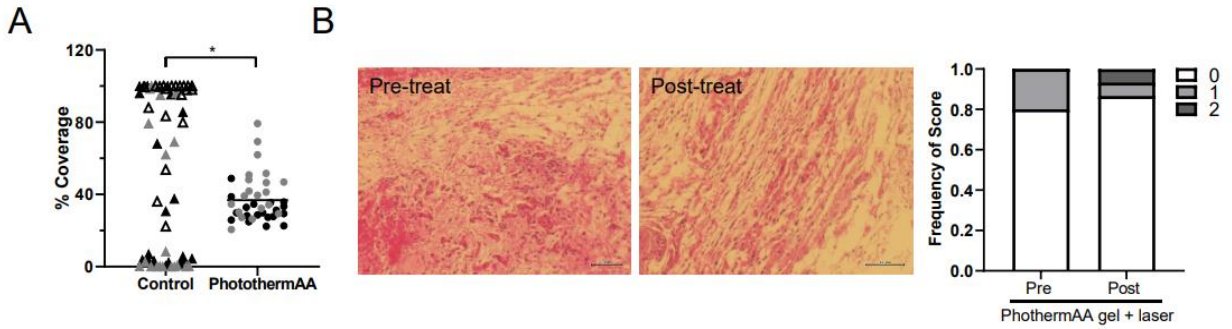


Figure 1. Efficacy and Safety of PhotothermAA gel
(A) SEM quantification of biofilm coverage of 20 standardized locations on the top surface of the implant, 1,500x magnification. Colored points are from each individual animal. Biofilm coverage was analyzed using Weka Trainable Segmentation plug-in for Fiji (n=3 for control and n=2 for PhotothermAA). (B) Representative H&E taken from periprosthetic tissue before and after PhotothermAA gel treatment, scale bar 100μM. Necrosis scores consist of 0 (no necrosis), 1 (necrosis less than 50% of fields observed), 2 (necrosis more than 50% of fields observed) scored by three blinded reviewers (n=8 for pre-treatment, n=5 for post-treatment).

833 The Burden of Obesity is Greater in Septic Revision Arthroplasty Versus Aseptic Revision Arthroplasty

Authors Cody Green, Taylor Rowe, Michael Valenzuela, Susan Odum, Thomas Fehring

Background And Rationale Obesity is associated with increased complications following joint replacement. Therefore, revision arthroplasty surgeons are likely to encounter more obese patients for both septic and aseptic indications. Ample literature exists demonstrating obesity as a risk factor for periprosthetic joint infection (PJI), but no literature exists comparing body mass index (BMI) and WHO Obesity Class between aseptic and septic revisions.

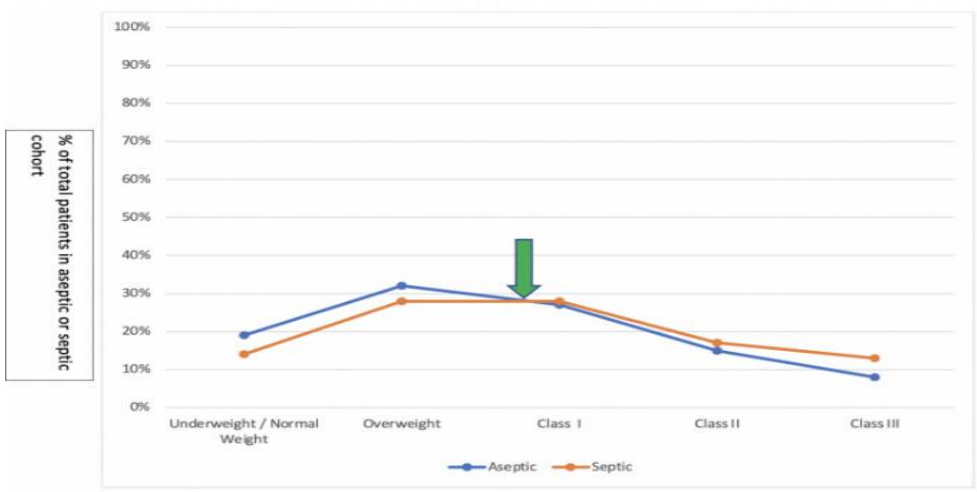
Study Question Is BMI and WHO body weight category at the time of surgery distributed differently between septic and aseptic total joint revision?

Methods A retrospective review was performed on all patients that underwent a revision total hip or knee arthroplasty at OrthoCarolina between January 2010 and July 2020. Patients were included if this was their first aseptic revision or first infection procedure and height/weight were available at time of surgery. The WHO Obesity Classification was used: Underweight (BMI <18.5), Normal (BMI 18.5-24.9), Overweight (BMI 25-29.9), Class I (BMI 20-34.9), Class II (BMI 35-39.9), Class III (BMI >40).

Results From 2010 to 2020, 10,300 revision TKA and THA were performed at OrthoCarolina, with 3,573 patients meeting inclusion criteria with BMI data available. There were 662 patients in the septic cohort and 2,911 patients in the aseptic cohort. Median BMI of patients in the septic cohort was 31.0 compared to 29.8 in the aseptic cohort ($p<.0001$). WHO Obesity Classes II and III represented a greater proportion of the septic cohort, while the WHO Underweight, Normal Weight, and Overweight categories made up a greater proportion of the aseptic cohort ($p<.0001$).

Discussion At our periprosthetic infection center, we have observed that obese patients represent the majority of PJIs. The data presented here confirms the observation. As BMI Class increases, a larger proportion of patients in the septic group existed compared to the aseptic group ($p<0.0001$), demonstrating that patients revised for PJI are significantly more obese than patients revised for aseptic reasons.

Conclusion Given this data, primary surgeons should be cautious before recommending arthroplasty in patients in high WHO Obesity categories.



832 Delayed Culture Results after Revision Delays Time to Antimicrobial Treatment

Authors Samuel Clarkson, Emanuele Chisari, Duncan Van Nest, Javad Parvizi

Background And Rationale Timely diagnosis and treatment of periprosthetic joint infection (PJI) is vital in mitigating its negative effects. Identifying the specific offending organism allows physicians to choose targeted antibiotics, leading to improved outcomes and appropriate antimicrobial stewardship. However, previous studies report that culture results can take many days to return, causing patients to undergo non-targeted treatment.

Study Question What is the amount of time from surgery to culture result and to initiation of definitive treatment?

Methods We queried our prospectively collected institutional database to identify patients with positive culture results following total knee arthroplasty (TKA) or total hip arthroplasty (THA) revision. Patient charts were reviewed for demographic and surgical data, as well as primary outcomes of time to first positive culture report, and time to initiation of definitive antibiotics. Multivariable regressions for both primary outcomes were performed, with independent variables including organism classification, polymicrobial infection vs. single organism, age, gender, BMI, ESR, and CRP.

Results Our overall cohort included 174 patients with positive culture results following THA revision (n=73) and TKA revision (n=101). The average number of days from sample collection to the earliest culture result was 3.18 days. Fifty-two patients began receiving definitive antibiotics prior to culture result, leaving 122 patients (70.1%) whose definitive antibiotic regimen relied on culture data. Among this sample, the average number of days from sample collection to the initiation of definitive antibiotics was 4.32 days. In multivariable regression, factors associated with decreased time to positive culture were elevated CRP, mixed gram-positive and gram-negative infections, and polymicrobial infections.

Discussion Targeted treatment of periprosthetic joint infection is critical in successfully eradicating the offending organisms without causing unnecessary systemic toxicity to the patient.

Conclusion Our data demonstrates a significant delay between intraoperative sampling and the determination of definitive antibiotic treatment for patients with PJI.

831 Positive Cultures in Aseptic Revision Arthroplasty: Are They Truly Contaminants?

Author Samuel Clarkson, Graham Goh, Javad Parvizi

Background And Rationale The burden of revision total joint arthroplasty (TJA) is steadily increasing. A significant percentage of revisions are considered to be aseptic, wherein no infectious cause can be identified. However, it is not uncommon to encounter a single positive culture in a subset of aseptic revisions.

Study Question The purpose of this study was to describe the organism profile and evaluate the clinical implications of a single positive culture in patients undergoing aseptic revision TJA as defined by validated criteria.

Methods A prospectively maintained institutional database was queried for all patients who underwent revision hip or knee arthroplasty from 2000 to 2017. Patients with aseptic revisions were identified using the 2018 International Consensus Meeting (ICM) criteria. Within this cohort, culture data was reviewed for any patients who had an organism isolated on an intraoperative tissue sample. Aseptic revision TJA patients with a single positive culture or multiple cultures positive for different organisms ("culture-positive group") were compared with patients who had negative intraoperative cultures ("culture-negative group"). Demographics, comorbidities, operative details, as well as any subsequent reoperations were recorded.

Results A total of 2,630 aseptic revisions were included, of which 186 (7.1%) were culture-positive. The most prevalent organisms were coagulase-negative staphylococci (42.9%), Propionibacterium acnes (8.2%), and Staphylococcus epidermidis (6.4%). Patient demographics and operative details were comparable between the culture-positive and culture-negative aseptic revision cohorts. There was also no significant difference in rates of subsequent reoperation (13.4% vs. 12.8%) or reoperation due to infection (2.7% vs. 1.8%).

Discussion Incidental positive cultures were not uncommon in patients undergoing aseptic revision arthroplasty.

Conclusion Notwithstanding, no difference in the rate of reoperation or subsequent infection was observed in this cohort, suggesting that single positive cultures may truly represent a false-positive result in aseptic revisions classified by validated criteria.

830 Multidrug Resistance in PJI Before and After H1N1 Pandemic

Authors Samuel Clarkson, Emanuele Chisari, Leanne Ludwick, Duncan Van Nest, Javad Parvizi

Background And Rationale Periprosthetic joint infection (PJI) is further complicated when the infecting organism is multidrug resistant (MDR). When an MDR organism is isolated, increased morbidity, failure rates, mortality, and costs are expected. The current pandemic caused by SARS-CoV-2 has resulted in measures that prevent spread of the virus, but could unintentionally cause increases in resistant organisms due to antibiotic pressure.

Study Question Our aim was to investigate trends in the rate of MDR in PJI, and hypothesize that the 2009 H1N1 pandemic resulted in an increased rate of resistance.

Methods We queried our prospectively collected institutional database for all patients who underwent revision hip or knee arthroplasty from 2006 to 2017. MDR was defined as resistance to three or more classes of antimicrobial. We compared the rate of MDR from 2006 to 2009 with 2010 to 2017 using a two-proportions z-test. We further analyzed subsets based on general class of organism (gram-positive, gram-negative, fungi), as well as more specific subsets of common organisms (S. aureus, CNS/S. epidermidis, Enterobacteriaceae).

Results Our cohort included 1153 organisms with susceptibility data. The overall rate of multidrug resistance was 34.1%. The rate of multidrug resistance decreased from 36.6% (2006 to 2009) to 32.9% (2010 to 2017). Comparing the two time periods, there was no statistically significant difference in the rate of multidrug resistance in either the overall cohort or in any of the analyzed subsets.

Discussion Decreased ability to isolate non-SARS-CoV-2 patients and decreased antimicrobial stewardship are major concerns of the current pandemic. While our study shows that the H1N1 pandemic in the US did not result in an increased prevalence of MDR species, long term effects of antibiotics might be overlooked.

Conclusion While resistance rate seems to not be affected by large national pandemics, other mechanisms like persistence cannot be excluded and should be investigated further.

829 Diagnostic Utility of Next Generation Sequencing in PJI

Authors Samuel Clarkson, Karan Goswami, Javad Parvizi

Background And Rationale Despite recent advances in the diagnosis of periprosthetic joint infection (PJI), identifying the infecting organism continues to be a challenge, with more than one-third of PJIs having negative cultures. Recent reports demonstrate that next-generation sequencing (NGS) facilitates pathogen identification in the context of culture-negative PJI (CN-PJI). However, the utility of NGS as an independent diagnostic adjunct has not been corroborated versus the current gold-standard 2018 ICM definition.

Study Question This multi-institutional prospective study was initiated to explore the ability of NGS to identify organisms in PJI.

Methods In this prospective multicenter study involving 15 academic institutions, samples were collected from 1,091 revision total joint arthroplasties (TJA). Synovial fluid, deep tissue and swabs were obtained at the time of surgery and shipped to the laboratory for NGS. Deep tissue specimens were also sent to the institutional lab for culture. Each revision TJA was classified as infected or noninfected using the 2018 International Consensus Meeting (ICM) definition of PJI.

Results Among the total cohort, 322 cases were considered to be infected. Of these, 298 (92.5%) had at least one positive pathogen signal on NGS, compared to 224 (69.6%) with one positive culture. Among the 75 patients with CN-PJI, 100% of patients had at least one positive NGS result. Patient of sample origin was highly significant and explained 59.9% of total variation among samples. In further analysis of 212 patients that were both NGS- and culture-positive, the most abundant species on NGS was the organism also found by culture in 51.6% of cases.

Discussion NGS was able to detect a pathogen in PJI at a much higher rate than culture, especially in culture-negative PJI.

Conclusion Our collaborative findings suggest that NGS is a useful adjunct for identifying the causative organism in PJI with diagnostic and failure prediction utility, particularly in the setting of negative cultures.

828 Can Next-Generation Sequencing Predict Treatment Failure for Periprosthetic Joint Infection?

Authors Samuel Clarkson, Karan Goswami, Javad Parvizi

Background And Rationale Surgical management of periprosthetic join infection (PJI) remains challenging, with patients failing treatment despite best efforts. An important question is whether these failures reflect reinfection or the persistence of infection.

Study Question In this multicenter study, we utilized next-generation sequencing (NGS) to study the hypothesis that majority of failures of two-stage exchange arthroplasty occur as a result of infection by organisms that were present at the time of resection arthroplasty as detected by NGS.

Methods This prospective multicenter study involving 15 academic institutions collected samples from 1,091 revision total hip (n=523) and knee (n=568) arthroplasties between 2016-2020. Synovial fluid, deep tissue and swabs were obtained at the time of surgery and shipped to the laboratory for NGS. Deep tissue specimens were also sent to the institutional lab for culture. Each revision TJA was classified as infected or noninfected using the 2018 International Consensus Meeting (ICM) definition of PJI. Treatment failure was defined as any reoperation for infection that yielded positive cultures. Concordance of the infecting pathogen cultured at failure with the NGS analysis at the initial revision procedure was determined.

Results Among the total cohort, there were 110 patients that were NGS-positive at revision and had a species-level culture result at failure. In this group, 69 patients (62.7%) had at least one sample from time of revision with an NGS result corresponding to the species cultured at failure. In similar analysis of 115 with genus-level culture data, 88 patients (76.5%) had at least one sample from time of revision with an NGS result corresponding to the genus cultured at failure.

Discussion The findings of this prospective, multicenter study suggests that there is a strong relationship between NGS signal during resection arthroplasty and subsequent failure at both the species and genus level

Conclusion Further studies should investigate the effect on outcome of using NGS results to guide antimicrobial treatment after revision.

827 Acute Kidney Injury Following Resection and Antibiotic-Loaded Spacer Insertion for Periprosthetic Joint Infection

Authors Graham Goh, Terence Thomas, Conor Drakeley, Ilan Small, Javad Parvizi

Background And Rationale It is often assumed that antibiotic-loaded spacers (ALS) deliver a high concentration of antibiotics into the joint without any deleterious systemic effects. However, there is a paucity of data on the incidence of systemic complications such as acute kidney injury (AKI) with the use of spacers.

Study Question What is the incidence of AKI following ALS insertion? What are the risk factors for this complication?

Methods We identified 312 patients who received an ALS for periprosthetic joint infection (PJI) at a single institution. AKI was defined as an increase in creatinine levels by 50% or 0.3 mg/dL within 48 hours. Demographics, comorbidities, intravenous antibiotics, ALS characteristics and organism profiles were compared between patients who developed AKI and patients who did not. Multivariable regression was used to identify factors associated with AKI and percentage change in creatinine.

Results The overall incidence of AKI was 9.3% (29 cases); 21 AKIs (7.4%) occurred in 283 patients with no history of chronic kidney disease (CKD), while 8 (27.6%) occurred in 29 patients with CKD (OR 4.70, 95% CI 1.86–11.88). No patients required dialysis. Multiple regression revealed that higher Charlson Comorbidity Index was independently associated with increased AKI risk (OR 1.40, 95% CI 1.10–1.77) but demographics, history of diabetes and hypertension were not. MRSA infections were associated with a four-fold increase in AKI (OR 3.81, 95% CI 1.38–10.54). A decrease in baseline hemoglobin of 1.0 mg/dL was associated with a 1.8 percentage-point increase in creatinine (beta 1.81, 95% CI 0.20–3.42).

Discussion The incidence of AKI in patients who receive antibiotic-loaded spacers is relatively high. Risk factors include history of CKD, higher comorbidities and lower baseline hemoglobin.

Conclusion The potential for systemic toxicity needs to be born in mind, particularly in patients with identified risk factors.

826 Do Extended Oral Antibiotic Prophylaxis Reduce the Incidence of Periprosthetic Joint Infections After Aseptic Total Hip or Knee Arthroplasty Revisions?

Authors Jesus Villa, Alison Klika, Tejbir Pannu, William Braaksma, Carlos Higuera, Aldo Riesgo

Background And Rationale Recent literature suggests that extended oral antibiotic prophylaxis after reimplantation reduces the rate of periprosthetic joint infections (PJI). However, there is no existing data regarding the effect of this prophylactic measure in aseptic first time revisions.

Study Question To ascertain whether the use of extended oral antibiotic prophylaxis decreases the incidence of PJI in aseptic total hip/knee arthroplasty first time revisions when compared to standard antibiotic prophylaxis (<24 hours).

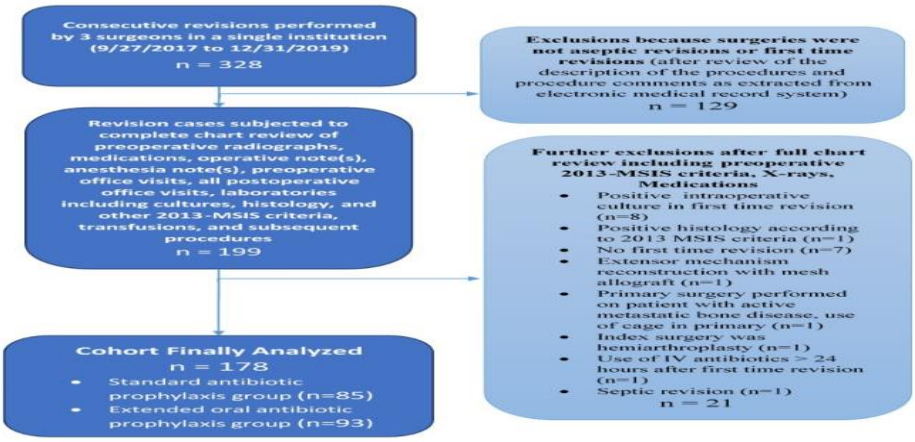
Methods Retrospective review of 328 consecutive revisions performed by 3 surgeons in a single institution (9/27/2017-12/31/2019). Inclusion criteria: aseptic total hip/knee arthroplasty first time revision. Exclusions: positive intraoperative cultures and/or histology per 2013-MSIS criteria, revision of hemiarthroplasty or partial arthroplasty, revision using foreign material (i.e., mesh), metastatic bone disease, IV antibiotics > 24 hours after surgery. The flowchart illustrating the case selection process is shown in Figure 1. Preoperative 2013-MSIS criteria, X-rays, and medications were reviewed. A total of 178 revisions were finally included, two groups were set apart: (1) standard antibiotic prophylaxis (<24 hrs.) (n=85) and (2) extended oral antibiotic prophylaxis (> 24 hrs.) (n=93). Demographics (age, gender, race, ethnicity), BMI, ASA, joint type (hip/knee), length of stay (LOS), skin-to-skin time, transfusions, discharge disposition (home/other), and the presence or not of PJI (per 2013-MSIS criteria) after the first time revision were compared between both groups. Mean follow-up was 476 days (1.3 years). Alpha was set at 0.05.

Results No statistically significant differences were found on demographics, BMI, ASA, joint type, LOS, transfusions, discharge disposition, or follow-up time. However, mean skin-to-skin time was significantly higher in the extended prophylaxis group (123 min vs. 98 min, p=0.01). The incidences of postoperative PJI were not significantly different: 2.2% (2/93) extended vs. 3.5% (3/85) standard (p=0.671).

Discussion Though not statistically significant, the rate of PJI was substantially lower (by 60%) in the extended prophylaxis group despite the increased operative time of these cases.

Conclusion Our data suggests that the use of extended oral antibiotic prophylaxis seems beneficial in lengthy aseptic revisions. However, further investigations with larger sample sizes are warranted to draw a definitive conclusion.

Figure 1. Flowchart illustrating the selection process undergone to include cases in standa antibiotic prophylaxis (≤24 hours) and extended oral antibiotic prophylaxis groups (> 24 hours)



825 Treatment of Antibiotic Resistant and Tolerant Persister and Phoenix Variants in Staphylococcus aureus and Pseudomonas aeruginosa Biofilms

Authors Kelly Moore, Anthony L,i Craig Delury, Phillip Laycock, Sean Aiken, Paul Stoodley

Background And Rationale Pseudomonas aeruginosa (PA) and Staphylococcus aureus (SA) are common pathogens in many nosocomial acute and chronic infections. In periprosthetic joint infections (PJI), antibiotic-loaded calcium sulfate beads (ALCSB) have been used in the management of PJI in part due to their versatile compatibility with many types of antibiotics alone and in combination. PA and SA both form biofilms which can harbor small populations of antibiotic resistant and tolerant variant cells.

Study Question In this study, we wanted to determine if combining two different dual antibiotic combinations within separate ALCSB types could more effectively kill these variants in SA and PA in-vitro biofilms compared to any one dual antibiotic bead type alone.

Methods ALCSB (Stimulan Rapid Cure) containing a) vancomycin (V) and tobramycin (T), or b) rifampin (R) and meropenem (M) were used. 24h agar lawn biofilms of bioluminescent PA or SA were challenged with a) either a single VT or RM bead or b) with a VT and RM bead distanced 3 or 8 cm apart to assess killing zone in overlapping regions. Bioluminescence and light images were used to assess metabolic activity and appearance of any variants. Replica plating was used to assess viability.

Results For both bacterial strains, each dual antibiotic bead completely killed biofilm bacteria in a zone immediately adjacent to each bead, however, the zone of killing varied.

Discussion The VT and RM beads distanced 3cm apart generated a greater zone of clearance and killed more variants than each bead type placed individually. The VT+RM beads distanced 3cm apart also generated more clearance than the two beads distanced 8cm apart.

Conclusion ALCSB distribution is an important factor in biofilm eradication and reduction of variant colonies in-vitro. Having two types of beads loaded with different antibiotics in close proximity does not negatively impact the killing zone of each bead.

824 Bacteriophage is More Efficacious in Treating MRSA Biofilm on Plasma Spray Titanium Surface Compared to Vancomycin

Authors Mariam Taha, Hesham Abdelbary

Background And Rationale Failure rate of standard treatment for Periprosthetic joint infection (PJI)is estimated to be around 40% at two years post revision surgery. A major clinical challenge contributing to treatment failure and antibiotics tolerance is the biofilm formation on implant surfaces. Lytic bacteriophages (phages) can target biofilm associated bacteria at localized sites of infection by penetrating and disrupting biofilm matrices; furthermore, phage replication within the biofilm leads to high local concentrations resulting in a powerful therapeutic effect. The aim of this study is to test if phage has better antimicrobial effect than vancomycin against premature (intra-operative contamination) and mature (established PJI) Staphylococcus aureus biofilms on titanium implant surface.

Study Question S. aureus BP043 was utilized in this study. This strain is a PJI clinical isolate, methicillin resistant (MRSA) and biofilm-former. Phage Remus, a lytic phage known to infect S. aureus, was used. S. aureus BP043 was grown as planktonic culture in 96-well plate or as biofilm at 3hr (premature biofilm) or 24hr (mature biofilm) on plasma sprayed titanium (Ti-6Al-4V) alloy disc surfaces. Planktonic cells were adjusted to ~ 1x109 CFU/mL in tryptic soy broth (TSB) and phage was added at about 1x109 PFU/mL with moi of 1 (a multiplicity of infection). Bacterial growth was assessed by measuring optical densities at 24hr and was compared to the control of S. aureus BP043 with no phage. Already established premature or mature biofilms were treated with phage at about 1x109 PFU/mL or with vancomycin at 500 ug/mL (sub- minimal biofilm eradication concentration) for 24hr in TSB at 37oC. Then, discs were sonicated and vortexed to dislodge bacteria. Bacterial survival was assessed by plating on tryptic soy agar plates. Survival in treated biofilms was compared to control biofilm that was exposed only to TSB.

Methods S. aureus BP043 was utilized in this study. This strain is a PJI clinical isolate, methicillin resistant (MRSA) and biofilm-former. Phage Remus, a lytic phage known to infect S. aureus, was used. S. aureus BP043 was grown as planktonic culture in 96-well plate or as biofilm cultures at 3hr (premature biofilm) or 24hr (mature biofilm) on plasma sprayed titanium (Ti-6Al-4V) alloy disc surfaces.

Results Planktonic cells growth in the presence of phage Remus was reduced significantly ($p < 0.0001$) after 24hr compared to the control with no phage. Exposing BP043 biofilm to the phage Remus resulted in more than 95% and 65% reduction in bacteria residing in the premature and mature biofilms, respectively. Vancomycin showed lower efficacy compared to the phage where there was a reduction of about 53% in premature biofilm and about 13% in mature biofilm cultures. Each experiment was repeated at least twice.

Discussion We have demonstrated that the usage of lytic phage contributes to better clearance of planktonic cultures of the S. aureus MRSA isolate. More importantly, viable bacteria in the mature biofilms that were grown on plasma sprayed titanium discs and treated with phage were reduced 5 more times compared to using vancomycin alone.

Conclusion This work is aimed at gathering preclinical evidence for using phage as a new therapeutic avenue to treat PJI.

823 Multidirectional Instability Following Primary Total Knees Associated with Metal Allergies

Authors Gerhard Maale, Aniruth Srinivasaraghavan, Nicole Kennard Arianne Mixon

Background And Rationale Patients can experience multiple problems following a primary Total Knee Arthroplasty (TKA). The causes of pain and swelling include infection, component loosening, multi-directional instability (MDI), and arthrofibrosis. MDI following a primary TKA is a clinical syndrome characterized by global ligament laxity, pain while getting up from a seated position, audible clunking of the implant, a feeling of instability in gait, and a warm knee effusion. Patients with MDI may be at a higher risk for failure secondary to metal allergies associated with arthrofibrosis, tissue reaction, and other symptoms that mimic infection.

Study Question Are metal hypersensitivities to knee implants associated with clinical MDI in patients following the placement of a primary TKA? Is MDI gender specific? What metals are commonly associated with MDI?

Methods In this study, patients presenting with clinical MDI following a primary TKA were subject to a Metal-Lymphocyte Transformation Test (metal-LTT) to determine any hypersensitivities to specific metal ions commonly seen in primary total knees. Those patients with metal hypersensitivities who elected to have a total knee revision using a Zirconium or Niobium prostheses were then included in the patient population in this study for statistical analyses.

Results Of the 206 patients experiencing MDI in our study group, 181 (88%) tested positive for metal hypersensitivity. Of the patients with metal allergies and MDI, 82% had a nickel allergy, 18% had allergies to other metals. The metal allergy associated with MDI was gender specific (2:1 female to male). P-value < .001 for both nickel allergy and gender. This form of failure after a primary occurs in 1.5% of all total joints based on 1,000 patients.

Discussion A significant correlation was found between the presentation of MDI and metal hypersensitivity; this study found the prevalence of metal sensitivity in patients with MDI following a primary TKA to be 88%. The patients presented with clinical symptoms similar to infection, however, extensive workup did not show infection. The significance of gender preference, 2:1 female to male is unknown.

Conclusion Metal hypersensitivities to knee implants is associated with MDI in patients with primary TKA implants. More research is necessary to elucidate whether it is a cause of the MDI or if MDI is the cause of the allergy.

822 Fungal and Mycobacterial Cultures Should Not be Routinely Obtained for Diagnostic Work-Up of Patients with Suspected Periprosthetic Joint Infection

Authors Don Tai, Nancy Wengenack, Robin Patel, Elie Berbari, Matthew Abdel, Aaron Tande

Background And Rationale Fungal and mycobacterial periprosthetic joint infections (PJIs) are rare events. Clinicians fear missing these diagnoses, often leading to routine ordering of fungal and mycobacterial cultures on periprosthetic specimens.

Study Question What is the utility of routine fungal and mycobacterial cultures in the diagnosis of PJI? How accurate are bacterial cultures in diagnosing fungal and mycobacterial PJI?

Methods A retrospective review was performed of patients diagnosed with hip or knee PJI between January 1, 2010, and December 31, 2019, at Mayo Clinic in Rochester, Minnesota. We included patients 18 years or older who had fungal, mycobacterial, or both cultures performed in addition to bacterial cultures. Cases with positive fungal or mycobacterial cultures were reviewed using the electronic medical record to classify the microbiologic findings as representing true infection or not.

Results There were 2,067 episodes of PJI diagnosed within the study period with a total of 3,629 fungal cultures and 2,923 mycobacterial cultures were performed. Test positivity rates of fungal and mycobacterial cultures were 5% (n=179) and 1.2% (n=34), respectively. After a comprehensive review, there were 40 true fungal and eight true mycobacterial PJIs. Bacterial cultures using BD BACTEC™ Plus Aerobic/F medium and BD BACTEC™ Lytic/10 Anaerobic/F medium blood culture bottles (BCB) were 90% sensitive in diagnosing true fungal PJI. BCB was 95% sensitive in the diagnosis of candidal PJI. BCB were negative in the H. capsulatum case and missed one case of Candida parapsilosis PJI. BCB were 100% sensitive in detecting rapidly-growing mycobacteria (RGM) with time-to-positivity ranging from four to seven days. BCB missed one case of slowly-growing mycobacteria (SGM) infection. Bacterial cultures utilizing solid bacterial agar and thioglycolate broth media did not yield mycobacteria.

Discussion True fungal PJI represented only 1.9% of all PJIs. Fungal cultures were unnecessary in most cases, as BCB recovered most fungal PJI pathogens, particularly Candida species. Notably, nearly half of the time, fungal cultures yielded clinically insignificant fungal organisms, leading to diagnostic uncertainty and risking unnecessary antifungal therapy and associated avoidable expenses.

True mycobacterial PJI was rare, representing only 0.4% of all PJI. RGM were more common causes of PJI compared to SGM. Specimens incubated for 14 days using BCB were adequate to recover these organisms.

Conclusion Routine fungal and mycobacterial synovial and periprosthetic tissue cultures have little utility in diagnosing PJI. BCB is accurate in diagnosing the most common types of fungal and mycobacterial PJIs.

Table 1 Performance of Bacterial and Fungal Cultures in Diagnosing Fungal Periprosthetic Joint Infection

	Accuracy (n/N) 95% CI	Sensitivity (n/N) 95% CI	Specificity (n/N) 95% CI	PPV (n/N) 95% CI	NPV (n/N) 95% CI
Fungal cultures	96.6% (1,123/1,162) 95.4%-97.6%	100% (40/40) 91.2%-100%	96.5% (1,083/1,122) 95.3%-97.5%	50.6% (40/79) 43%-58.3%	100% (1,083/1,083) -
Bacterial blood culture bottle-based cultures	99.6% (547/549) 98.7%-100%	90% (18/20) 68.3%-98.8%	100% (529/529) 99.3%-100%	100% (18/18) -	99.6% (529/531) 98.6%-100%
Bacterial agar and thioglycolate broth cultures	98.9% (608/613) 97.7%-100%	65% (13/20) 43-87%	100% (593/593) 99.4%-100%	100% (13/13) -	98.8% (593/600) 97.7%-99.5%

Abbreviations: n/N, number/total; CI, confidence interval; PPV, positive predictive value, NPV, negative predictive value

821 Comparison of One Stage versus Two Stage Revisions for Infected Total Knees

Authors Gerhard Maale, Aniruth Srinivasaraghavan Nicole Kennard Arianne Mixon

Background And Rationale The efficacy of the one stage knee revision for PJI over the two-stage alternative is still under contention. The conventional treatment for periprosthetic joint infections (PJI) of the knee is the two-stage revision requiring the use of an antibiotic loaded spacer followed by a delayed exchange.

Study Question Do single-stage revisions of infected total knees provide comparable or possibly better patient outcomes to those reported for two-stage revisions?

Methods We retrospectively reviewed 376 cases of one-stage revisions of knees between 2005-2018. Patient comorbidities, which included both local and systemic compromises, were reviewed for all patients using McPherson's classification system for PJIs and patients were subsequently staged. All patients in our cohort presented with PJI of the knee and subsequently underwent a one stage revision using dual setup with radical debridement, definitive knee reconstruction with antibiotic loaded cement and implantation of antibiotic loaded calcium sulfate hemihydrate pellets. Successful treatment was defined as a knee joint without recurrence of infection, for a minimum of 2 years, and limb preservation.

Results The patients in this cohort had a mean follow-up of 60 months and mean patient age of 61 years old (194 males and 182 females). Almost all of the patients were classified as McPherson type III-C-3. One hundred and four out of the 376 patients required flaps; 16 local flaps and 98 free muscle flaps. Forty-four patients had some form of recurrence. Of the 44 patients that recurred, 14 required an amputation. All patients who had a recurrence of infection presented with draining sinus tracts with dislocations (18%) and wound healing problems (27%) being a major contributing factor.

Discussion A one-stage treatment of the knee is more cost-effective by at least 50% and is not associated with some of the physically debilitating complications seen in patients treated with two-stage revision. Based on our study group, one-stage revision of infected total knees demonstrates an infection eradication rate of 86%.

Conclusion Compared to a previous study of two stage revisions (N=2000) which demonstrated an 85% eradication rate, we believe that our procedure demonstrated a comparable eradication rate (88%). With added advancements to antibiotic delivery mechanisms, we believe that the one stage treatment for total knees will be a more popular treatment option for patients with PJI both from a cost standpoint and early functionality.

820 Preliminary study of anesthetic-loaded chitosan-mannitol-PEG paste to reduce S. aureus bioburden.

Authors Emily C Coleman, Carlos Wells, Luke Tucker, Zoe Harrison, Lauren Priddy, J. Jennings

Background And Rationale Local anesthetics, such as bupivacaine (BUP), have reported antimicrobial properties with their pain reduction capabilities. In pre-clinical models, chitosan and polyethylene glycol (PEG) paste combined with bio-additives such as mannitol and fatty acids eluted antimicrobials to effectively prevent infection.

Study Question We asked the question, can BUP-loaded chitosan-mannitol-PEG paste treat biofilm-associated infection?

Methods Paste solution (0.85% acetic acid, 1% chitosan, 1% PEG, and 2% mannitol) was lyophilized and ground into a powder. A portion of the paste was hydrophobically modified in pyridine and hexanoic anhydride. Ethanol-solubilized BUP was added to the paste (84 mg/500 mg ratio), and ethanol was evaporated off. Paste was hydrated by mixing unmodified paste with saline (500 mg/6 mL ratio), then mixing with 500 mg of loaded paste. Femoral defects (1.2 mm diameter) were created in adult CD rats, and an orthopedic screw soaked in bacterial suspension (~1x108 CFU S. aureus) was inserted. After 7 days, the screw was removed, bone was debrided with a 1.5 mm drill bit, and the infection was treated with material from one of 3 groups (n=3): unloaded paste (150 mL), BUP-loaded paste (150 mL), or no treatment. IVIS imaging was performed on representative animals throughout the study, and rats were euthanized 4 weeks post-treatment with tissue samples harvested for bacteriological analysis.

Results Loaded paste had lower average CFU counts for bone, although no statistically significant differences were detected due to small sample size (Fig 1). IVIS images indicated that loaded paste may have reduced bacterial growth at early time points more than unloaded paste or controls.

Discussion Although not statistically significant, the results model a bioburden reduction trend. More animals and time points are needed in future studies to determine efficacy. IVIS qualitative results about bacterial reduction at early time points should be confirmed with CFU counts. Also, this study modeled a treatment for existing biofilm-based infection, without systemic antimicrobial administration. Future studies will evaluate the paste for prevention and with antibiotics and antimicrobials. While pain indicators were not assessed, the release of local anesthetic may also reduce morbidity after procedures.

Conclusion BUP-loaded chitosan-mannitol-PEG paste may have a role in reducing bacterial bioburden to prevent or treat infection for complex musculoskeletal trauma or periprosthetic joint infection.

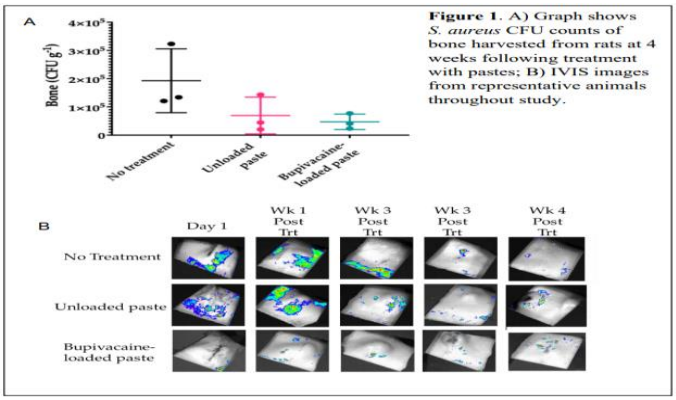


Figure 1. A) Graph shows *S. aureus* CFU counts of bone harvested from rats at 4 weeks following treatment with pastes; B) IVIS images from representative animals throughout study.

819 Halicin: a novel antibacterial agent active on Staphylococcus aureus biofilms

Authors Shota Higashihira, Stefanie Simpson, Christopher Collier, Roman Natoli, Mizuho Kittaka, Edward Greenfield

Background And Rationale Biofilms protect bacteria from both the immune system and many antibiotics, thereby making the treatment of prosthetic joint infection (PJI) extremely difficult. Our goal is therefore to develop novel therapeutic interventions to reduce the devastating complications of biofilms. A neural network deep learning approach recently identified broad-spectrum antibacterial activity of halicin (SU3327), a nitrothiazole compound structurally different than known antibiotics (Stokes et al 2020 Cell 180:688-702.e13). Halicin displayed potent activity against murine soft-tissue infections and planktonic forms of many bacterial species, including S. aureus, the most common cause of PJI (Stokes et al 2020). Importantly, halicin did not induce resistance in vitro and was effective against both drug-resistant bacteria and planktonic persister cells (Stokes et al 2020) which phenocopy many aspects of bacteria in biofilms. However, whether halicin acts on biofilms has not been tested previously.

Study Question Test the hypothesis that the antibacterial activity of halicin extends to S. aureus biofilms.

Methods S. aureus-Xen36 (Caliper Life Sciences) biofilms were grown on polystyrene pegs by incubating 9x104 cells/well for 72 hours in 96-well Calgary Biofilm Devices (Innovotech) with gentle shaking (Ceri et al 1999 J Clin Microbiol 37:1771-6). After rinsing in PBS, biofilms were incubated for 20 hours in LB broth containing various concentrations of halicin (Tocris) or conventional antibiotics. Biofilms were allowed to recover in LB broth for 24 hours. Minimal biofilm eradication concentrations (MBECs) were then determined by resazurin reduction assays. Planktonic minimum inhibitory concentrations (MICs) were determined using the absorbance-based CLSI protocol. All experiments were repeated >3 times.

Results MBECs for cefazolin and vancomycin were, respectively, 12.5-25 fold and 200 fold greater than their planktonic MICs (Table 1). These differences confirm biofilm formation in our cultures (Ceri et al 1999). In contrast to cefazolin and vancomycin, biofilm MBEC and planktonic MIC were equivalent for halicin (Table 1 & Fig 1).

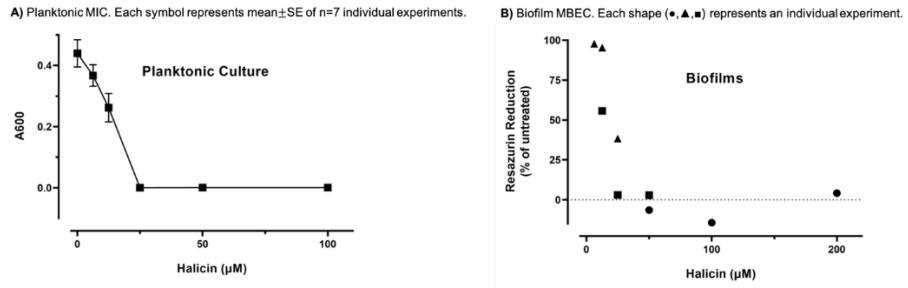
Discussion Future studies should test halicin in animal models of PJI using a once-daily dosing regimen effective against murine soft-tissue infections (Stokes et al 2020).

Conclusion In contrast to many conventional antibiotics, halicin has equivalent effects on S. aureus in planktonic cultures and biofilms.

Table 1.

Antibiotic	Planktonic MICs (μM)	Biofilm MBECs (μM)
Cefazolin	1	12.5-25
Vancomycin	0.5	100
Halicin	25	~50

Figure 1.



818 Prevalence of Fungal Pathogens in Periprosthetic Joint Infections

Authors Paulo Castaneda, Alex McLaren, Varun Sharma, Carl Deirmengian

Background And Rationale Periprosthetic infection (PJI) is caused by a spectrum of biofilm forming microorganisms including fungi. Historically, PJI pathogens have been reported in PJI outcome studies, typically small numbers across limited geographic locations and single enrollment periods. Data management systems in national laboratories provide an opportunity to study PJI pathogens independent of investigator and institution bias, across location and time. Fungal pathogens are less common and more difficult to diagnose presenting a larger epidemiologic challenge than bacterial PJI pathogens.

Study Question What are the fungal pathogens that cause PJI in the United States (USA) by location and time?

Methods Synovial cultures performed by an independent national diagnostic laboratory (CD Diagnostics, Claymont, DE. (CDD)) were analyzed to determine the prevalence of fungal PJI pathogens. Cultures were stratified over time (2014-2019) and by National Inpatient Sample (NIS) regions. This study was determined exempt by UA, COM-P IRB.

Results Culture results were available on 106,075 samples, 13,947 were positive for bacterial pathogens (reported in 2020), and 535 for fungal pathogens (3.8% of positive samples). CDD specimen collection is concordant with the PJI prevalence across USA (R2 = 0.84). 13 fungal genera were identified: Candida, Fusarium, Aspergillus, Scedosporium, Phialophora, Sporothrix, Coccidioides, Acremonium, Torulopsis, Alternaria, Graphium, Mucor, and Geotrichum. 91.6% of all fungal pathogens were Candida. C. albicans 45.5% and C. parapsilosis 37.5%, were the 1st and 2nd most common species both annually (2014 – 2019) across all 9 NIS regions. The remaining 12 genera made up 8.4%. The top 6 species were Candida sp, followed by Aspergillus fumigatus (1.3%). All other species were 1.2% or less and varied by time and region.

Discussion . C. albicans and C. parapsilosis were the two most common fungal PJI pathogens in the USA and did not vary over 5 years between 2014-2019 or by region.

Conclusion Fungal pathogens account for 3.8% of PJIs in the United States

Table 1: Fungal PJI Pathogens: 2014-2019

Genus/Species	2014	2015	2016	2017	2018	2019	Total
Candida	19	45	85	114	130	95	490
albicans	5	16	44	53	61	43	223
dubliniensis	1		2	2	1	1	7
glabrata		1	6	10	11	2	30
guilliermondii						1	1
krusei				1			1
lusitaniae		2		2	1	4	9
metapsilosis					2	1	3
orthopsilosis				2	1		3
parapsilosis	12	23	25	38	43	42	184
pelliculosa			1				1
tropicalis	1	3	7	6	10	1	28
Aspergillus			1	1	3	2	7
fumigatus			1	1	2	2	6
nidulans					1		1
Scedosporium				2	1	1	4
apiospermum				1	1	1	3
prolificans				1			1
Phialophora					1	2	3
verrucosa					1		1
Sporothrix					2	1	3
schenckii					1	1	2
Coccidioides	1	1			1		3
immitis	1	1					2
immitis/posadasii					1		1
Torulopsis	2						2
glabrata	2						2
Coccidiioides				1			1
immitis/posadasii				1			1
Geotrichum			1				1
klebahnii			1				1
Unspecified Species							
Fusarium				2	1	4	7
Acremonium		2				1	3
Alternaria	1						1
Graphium		1					1
Mucor				1			1
Yeast		1		1	5		7
Mold					1		1
Grand Total	23	50	87	122	145	106	535

817 Racial disparities in the risks of septic and aseptic revision total knee replacements

Authors Susan Goodman, Anne Bass, Huong Do, Bella Mehta, Stephen Lyman, Serene Mirza, Michael Parks, Mark Figgie, Lisa Mandl

Background And Rationale Black patients have higher risk of revision total knee replacement (rTKR) than White patients, but whether these disparities exist for both septic and aseptic rTKR is unknown. This study examined racial disparities for septic and aseptic rTKR risk separately.

Study Question Are there racial disparities in both septic and aseptic rTKR risk?

Methods Retrospective observational cohort study. Cox regression models to assess impact of race on risk of septic and aseptic rTKR. Patient and hospital level data obtained from the New York Statewide Planning and Research Cooperative System, California's Office of Statewide Health Planning and Development, and the Healthcare Utilization Project Florida State Inpatient Databases, 2004-2014. Patient zipcode-level community characteristics were calculated from US Census variables.

Results 722,492 patients underwent primary TKR, 445,616 (61.7%) female and 61,092 (8.5%) Black (Table 1). Black patients had higher risk of septic (HR 1.11, 95% CI 1.03-1.20) and aseptic (HR 1.39, 95% CI 1.33-1.46) rTKR . Other risk factors for septic rTKR were diabetes, obesity, renal disease, COPD, inflammatory arthritis, primary TKR surgical site complications, Medicaid, and having primary TKR performed at hospital with lower annual TKR volume. Risk factors for aseptic rTKR were male sex, workers compensation, and lower hospital annual TKR volume. Separate analyses for subgroups by hospital TKR volume category showed the HR (95% CI) for aseptic rTKR for Black vs White patients was 1.20 (1.04-1.37) at very low volume hospitals (≤ 89 TKR per year) compared to 1.68 (1.48-1.90) at very high volume hospitals (≥ 645 TKR per year).

Discussion This observational cohort study showed that Black patients had 11% higher risk of septic rTKR compared to White patients, but a 39% higher risk of aseptic rTKR. Racial disparities in aseptic rTKR risk were greatest at high TKR volume hospitals. Racial disparities in rTKR were greater for aseptic than for septic revision and were also associated with characteristics of the hospital where the primary TKR was performed.

Conclusion Black patients have higher risk of aseptic and septic rTKR compared to White patients. Racial disparities in aseptic revision risk were greatest at very high TKR volume hospitals.

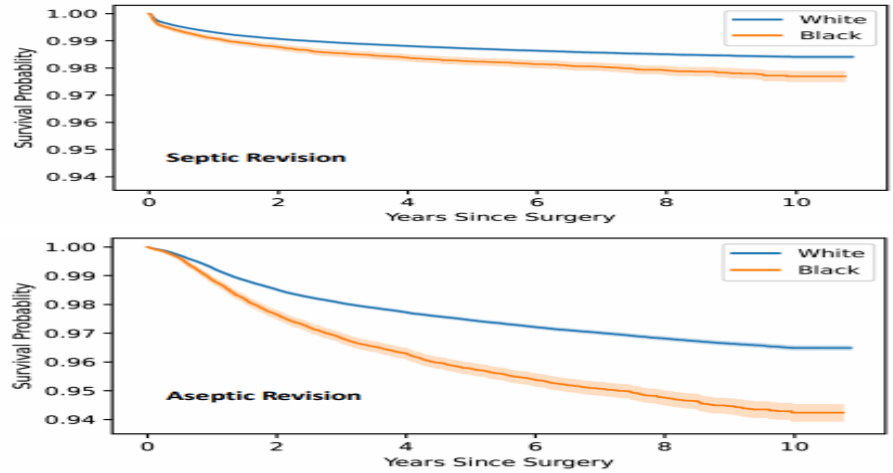


Figure 1. Kaplan-Meier time to event analysis demonstrating time to septic total knee replacement revision (top) and aseptic total knee replacement revision (bottom) in Black patients vs. White patients. Kaplan-Meier analysis showed 1, 3 and 5-year septic revision rates (95% confidence intervals) of 0.9%(0.8%-1%), 1.5%(1.4%-1.6%) and 1.8%(1.6%-1.9%) among Black patients and 0.7%(0.7%-0.7%), 1.1%(1.1%-1.1%) and 1.3%(1.3%-1.3%) among white patients, and 1, 3 and 5-year aseptic revision rates of 1.1%(1.1%-1.2%), 3.2%(3.0%-3.3%) and 4.2%(4.0%-4.4%) among Black patients and 0.7%(0.7%-0.7%), 1.9%(1.9%-2.0%) and 2.5%(2.5%-2.6%) among white patients during a mean (SD) 3.8(2.8) years of surveillance

816 Short versus Long Duration of Intravenous Antibiotics in Prosthetic Joint Infections: Systematic Review and Meta-Analysis

Authors Nour Bouji, Matthew Dietz

Background And Rationale Prosthetic joint infection (PJI) is one of the leading causes for total hip and knee arthroplasty failure and is associated with significant morbidity and mortality. Usually, a long course of antibiotic including intravenous (IV) and oral routes are required for its treatment. While most researchers are focusing on a shorter duration of overall antibiotic course, this systematic review and meta-analysis emphasize on the parenteral component of the antibiotic course and this emerged from the requirements and burden associated with this route of administration.

Study Question The aim of this meta-analysis is to compare short duration versus long duration IV antibiotic outcomes in PJIs.

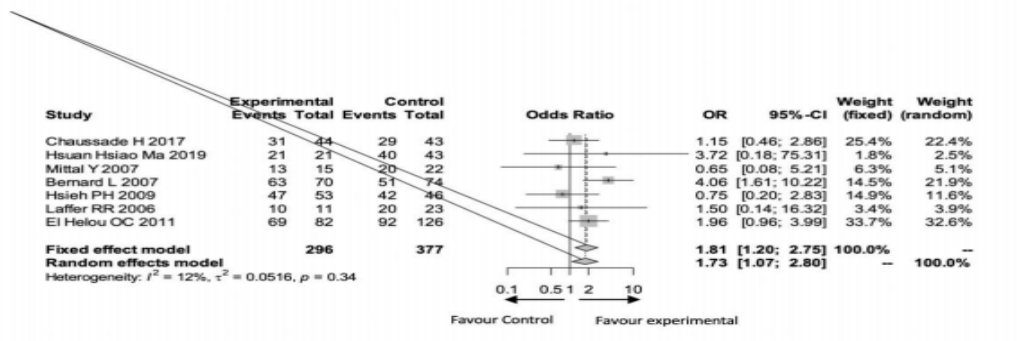
Methods Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), Cochrane Library, MEDLINE/PubMed and Scopus were searched using predefined medical subject headings (MeSH). All searches were done on the third week of February 2021 and only comparative studies were included.

Results Eight studies were included reporting 383 TKAs and 393 THAs performed in 776 patients. This meta-analysis showed no significant difference in the overall success rate when comparing short duration versus long duration IV antibiotics in PJI (95% CI: 0.68 – 2.43, p=0.44). However, due to the high heterogeneity shown in the overall success rate measured across all the eight included studies, an adjusted success rate was done after the exclusion of one of the studies. The adjusted success rate showed a statistically significant difference between the two groups (95%CI: 1.07 – 2.80, p=0.02) and reflected a more homogeneous population.

Discussion An initial shorter duration of IV antibiotics treatment in THA and TKA related PJI may be as effective or superior when compared with long duration. A shorter duration of IV antibiotics would likely shorten the overall length of hospital stay, be less invasive, diminish the occurrence of adverse side effects and the emergence of antimicrobial resistance in patients. A lower economic cost on patients and overall healthcare system is expected as well.

Conclusion The impact of transitioning to short duration of IV antibiotics could play a significant role in improving the care that is provided to patients suffering from PJI. However, to ensure that this transition is made safely further evaluation should occur. Given the rarity of this complication it would likely require a multi-center randomized controlled trial.

Forest Plot: Adjusted Success rate in short duration (Experimental) versus long duration (Control) IV antibiotics treatment in in THA or TKA related PJI



Experiment: Short duration IV antibiotic, Control: Long duration IV antibiotic

815 Improved Complication Rates Following Total Hip and Knee Arthroplasty in Patients with Treated Hepatitis C

Authors Kenneth Schmidt, Rebecca Chun, Diep

Background And Rationale Hepatitis C virus (HCV) is the most common blood borne infection in the United States. Literature suggests that chronic HCV is associated with poorer outcomes following orthopedic surgery. This poses a significant issue when considering an aging patient population and the expected increase in demand for total joint arthroplasty.

Study Question The purpose of this study is to determine whether treatment of hepatitis C is associated with decreased complication rates in adults undergoing total hip or knee arthroplasty.

Methods A single institution retrospective review of patients diagnosed with HCV who underwent primary total hip or knee arthroplasty between October 2013 and November 2020 was conducted. A total of 35 total joint arthroplasties was performed amongst 30 adults. Patients were divided into 2 cohorts consisting of subjects with cured HCV (C-HCV; n=26) and treatment naive HCV (TN-HCV; n=9). Pre-operative values of hemoglobin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and international normalized ratio (INR), as well as Model for End-Stage Liver Disease (MELD) scores were compared. Postoperative complication rates within 1 year of follow-up were also evaluated.

Results The mean complication rate in C-HCV and TN-HCV groups was 19.2% and 55.6% respectively ($p=0.081$). Treatment naive HCV was associated with a significantly increased risk of postoperative complications when compared to the cured HCV (odds ratio=48.5; $p=0.03$). Pre-operative ALT and AST values were significantly greater in the TN-HCV group ($p<0.05$). There was no statistically significant difference in pre-operative hemoglobin, INR, or MELD scores.

Discussion The number of patients with HCV undergoing orthopedic surgery is expected to increase with the aging patient population. The data from this study suggests that the risk of postoperative complications is significantly increased in patients with treatment naïve HCV. Though this finding is consistent with prior studies, limitations of this study, including its retrospective nature as well as small sample sizes, should be taken into consideration.

Conclusion Treatment of hepatitis C appears to be associated with decreased risk of postoperative complications following primary total joint arthroplasty. Patients with HCV should be evaluated for and counseled on perioperative risks prior to undergoing surgery.

814 Improved Outcomes with Inpatient Antibiotic Administration in Recreational Intravenous Drug Users with Orthopaedic Infections

Authors Erin Stockwell, Kent Rinehart, Angela Hewlett, Phlipp Streubel

Background And Rationale Treatment of bone and joint infections in recreational IV drug users (RIVDU) pose special challenges as prolonged intravenous catheter placement may lead to significant complications. However there is a paucity of data regarding antibiotic therapy in this setting.

Study Question Are there differences in clinical outcomes between inpatient and outpatient antibiotic administration in RIVDU patients who require long-term antibiotic therapy for the treatment of orthopaedic infections?

Methods This is a retrospective review of all patients admitted to an academic medical center between 01/01/2011 and 12/31/18 with a diagnosis of one infection of interest (epidural abscess, osteomyelitis, prosthetic joint infection, septic arthritis) as well as a history of RIVDU (n=41). Five cohorts were established based on location of antibiotic administration: exclusively inpatient IV therapy (n=12), home with home healthcare IV therapy (n=3), home with oral medications (n=11), infusion center IV therapy (n=9), skilled nursing facility IV therapy (n=6). These five cohorts were compared by mean hospital length of stay, resolution of infection at 6 or 12 months, compliance with therapy, readmission rates,, and loss to follow up.

Results The inpatient therapy cohort had a median length of stay of 41 days, which was significantly longer than all other cohorts ($p<0.0001$). At 6-month follow up, the inpatient cohort had 100% resolution of infection, which was significantly better than the resolution of all other cohorts ($p=0.0019$). The inpatient cohort also had lower readmission rates in the seven year study period compared to the other cohorts ($p=0013$). There was no difference between the five patient cohorts with regards to resolution of infection by 12 months, or loss to follow up.

Discussion RIVDU patients who suffer from bone or joint infections pose a special challenge and little data is available to guide treatment. RIVDU demand more complex medical decision making and suffer from more severe medical comorbidities. Remaining inpatient for the duration of treatment places an increased cost burden on the healthcare system. Further research is needed to determine how antibiotic treatment can be optimized in this patient population, ideally in the outpatient setting.

Conclusion This study shows that RIVDU have better clinical outcomes when they remain inpatient for the duration of their treatment.

813 Non-aspirin thromboprophylaxis is not associated with early prosthetic joint infection in total hip arthroplasty

Authors Vinay Aggarwal, Chelsea Sicat, Utkarsh Anil, Noah Kirschner, Greg Teo, Katherine Lygrisse, Ran Schwarzkopf, William Long

Background And Rationale Chemoprophylaxis for venous thromboembolism (VTE) in total hip arthroplasty (THA) patients includes aspirin (ASA) and more potent chemoprophylaxis; the latter can lead to increased rates of bleeding and wound complications.

Study Question This study aims to evaluate the effect of non-ASA chemoprophylaxis on rates of early prosthetic joint infection (PJI) following THA.

Methods A review of all patients undergoing primary THA from 2013-2019 at a single academic orthopedic hospital was conducted. The primary outcome measure was PJI within 90 days of surgery as measured by Musculoskeletal Infection Society (MSIS) criteria. Chi-square analysis and Mann-Whitney U test were used to determine statistically significant relationships between risk factors and outcomes. Significance was set at $P < 0.05$. Multivariate logistic regression was performed to control for identified independent risk factors for PJI.

Results A total of 11,262 THA were included in the study: 3,932 (34.9%) received non-ASA chemoprophylaxis and 7,330 (65.1%) received ASA-exclusive chemoprophylaxis. BMI, CCI, male gender, history of diabetes and history of rheumatic disease were found to be significant predictors of PJI. Non-ASA chemoprophylaxis was not shown to be a significant predictor of early PJI in the univariate analysis ($p=0.94$).

Discussion We did not find an association between PJI and use of non-ASA chemoprophylaxis following primary THA. This contrasts with our previous findings that non-ASA use is independently associated with higher rate of early PJIs in total knee arthroplasty, suggesting that the soft tissue anatomy of hips may be less susceptible to wound complications and infection.

Conclusion Non-ASA chemoprophylaxis is not associated with higher rates of early PJI following THA.

812 Aspirin thromboprophylaxis following primary total knee arthroplasty is associated with a lower rate of early prosthetic joint infection compared with other chemoprophylactic agents

Authors Vinay Aggarwal, Chelsea Sicat, Utkarsh Anil, Noah Kirschner, Greg Teo, Katherine Lygrisse, Ran Schwarzkopf, William Long

Background And Rationale Patients undergoing total knee arthroplasty (TKA) are at increased risk of venous thromboembolism (VTE). Aspirin (ASA) has been shown to be effective at reducing rates of VTE. In selected patients, more potent chemoprophylaxis is indicated, which can lead to increased rates of bleeding and wound complications.

Study Question This study aims to evaluate the effect of non-ASA chemoprophylaxis on rates of early prosthetic joint infection (PJI) following TKA.

Methods A review of all patients undergoing primary TKA from 2013-2019 at a single academic orthopedic hospital was conducted. The primary outcome measure was PJI within 90 days of surgery as measured by Musculoskeletal Infection Society (MSIS) criteria. Chi-square analysis and Mann-Whitney U test were used to determine statistically significant relationships between risk factors and outcomes. Significance was set at $P < 0.05$. Multivariate logistic regression was performed to control for identified independent risk factors for PJI.

Results A total of 11,547 patients undergoing total knee arthroplasty from January 2013 to September 2019 at an academic medical center were included in the study. Non-ASA chemoprophylaxis was administered to 4,941 (42.8%) patients and ASA-exclusive chemoprophylaxis was given to 6,606 (57.2%) patients. Multivariate logistic regression adjusted for age, BMI, gender, Charlson Comorbidity Index, and history of diabetes revealed that patients given ASA-exclusive chemoprophylaxis had significantly lower odds of PJI (OR 0.542, 95% CI:0.305 -0.944, p=0.033) compared to non-ASA patients.

Discussion The use of non-ASA chemoprophylaxis following primary TKA is independently associated with a higher rate of early PJIs. Arthroplasty surgeons should consider ASA as the gold standard chemoprophylaxis in all patients in which it is deemed medically appropriate and should carefully weigh the morbidity of PJI in patients when non-ASA chemoprophylaxis is considered.

Conclusion Non-ASA chemoprophylaxis following primary TKA is independently associated with a higher rate of early PJIs.

811 Comparative Outcomes and Surgical Timing for Operative Fragility Hip Fracture Patients During the COVID-19 Pandemic

Authors Antonia Chen, Katherine Rowe, Kiryung Kim, Nathan Varady, Marilyn Heng, Arvind von Keudell, Michael Weaver, Ayesha Abdeen, Edward Rodriguez

Background And Rationale Despite the wide-reaching effects that the COVID-19 pandemic has had on healthcare systems, data of its impact on operative hip fracture patient care are limited, and geographic differences may exist due to variations in pandemic severity and response. The role of COVID-19 testing and its interplay with possible surgical delays has not been explicitly investigated.

Study Question This study aimed to characterize surgical outcomes and timing among patients treated for operative hip fractures during the COVID-19 pandemic in the New England region of the United States. It also sought to investigate the role of COVID-19 testing in preoperative care.

Methods A retrospective observational study was conducted from 3/16/2020-5/20/2020 with a consecutive series of operative hip fracture patients at three tertiary academic medical centers during the COVID-19 pandemic. These patients were matched with historical controls based on sex, surgical procedure, age, and comorbidities. Primary outcomes included 30-day mortality and time-to-surgery. Secondary outcomes included time to COVID-19 test result (if applicable), 30-day post-surgical complications, length-of-stay, and disposition. Outcomes were compared with Chi-square tests for categorical variables and t-tests for continuous variables.

Results During the study period, 64 patients underwent operative hip fracture repair, 58% of whom underwent preoperative COVID-19 testing. In comparison to historical controls, there was no increase in 30-day mortality or post-operative complication rates. There was no difference in time-to-surgery despite a mean time from presentation to final COVID-19 test result of 17.6 hours. Notably, 23.8% of patients were discharged to home during the COVID-19 pandemic compared to 4.8% among controls ($p<0.01$), and there was an increase in the use of spinal or local anesthesia from 9.4% in controls to 18.8% during the pandemic, although this did not reach the threshold for significance ($p=0.13$).

Discussion Given that COVID-19 testing is now an essential piece of preoperative planning, it is reassuring that testing did not delay surgery in this population. The lack of difference in 30-day outcomes suggests that safe discharge home may be possible in a greater proportion of patients.

Conclusion The COVID-19 pandemic impacted perioperative management, including increased utilization of spinal or local anesthesia and increased home discharge. However, mortality and complications were similar between groups. COVID-19 testing did not delay surgery.

Table 1. Comparison of thirty-day post-operative outcomes.

	Cases (n=64)	**Controls** (n=64)	**p-value**
ED Visits	19% (12)	30% (19)	0.15
Readmissions	16% (10)	17% (11)	0.81
Reoperation	2% (1)	2% (1)	1.00
Any Complication	38% (24)	45% (29)	0.37
Individual Complications			
Surgical site infection	2% (1)	2% (1)	1.00
Gastrointestinal complications (vomiting)	8% (5)	5% (3)	0.47
Pneumonia	11% (7)	9% (6)	0.77
Myocardial infarction	5% (3)	3% (2)	0.65
Stroke	2% (1)	2% (1)	1.00
Sepsis	5% (3)	5% (3)	1.00
Severe bleeding	9% (6)	5% (3)	0.30
Congestive heart failure	6% (4)	6% (4)	1.00
Deep vein thrombosis	2% (1)	3% (2)	0.56
Pulmonary embolus	2% (1)	3% (2)	0.56

ED: Emergency Department

810 Timing of Antibiotic Initiation in the Treatment of Hip and Knee Septic Arthritis

Authors Jared Alswang, Nathan Varady, Vineet Desai, Adam Olsen, Antonia Chen

Background And 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 hip and knee septic arthritis patients.

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

Methods A retrospective analysis was conducted at two separate hospital systems on 345 patients with hip or knee septic arthritis admitted from 1/2000-5/2014 (system 1) and 3/2016-11/2018 (system 2). Patients with periprosthetic joint infections and those without recorded intervention times – initiation of antibiotic administration and culture timing – were excluded from the analysis. In patients with multiple septic joints, each joint was analyzed individually (n=347; hip: n=101; knee: n=246). Diagnosis was determined by irrigation & debridement and/or a positive culture. Patients were grouped based on antibiotic therapy timing: >24 hours prior to arthrocentesis (Group 1), < 24 hours prior (Group 2), and post-arthrocentesis (Group 3).

Results No difference was observed in positive cultures between groups (p=0.67): Group 1=54.0% (47/87), Group 2=59.7% (46/77), and Group 3=59.6% (109/183). Similarly, frequency of related readmissions within 30 days did not significantly differ (p=0.66; Groups: 12.6%, 15.6%, 11.5%). Additionally, there were no significant differences in culture sensitivity in the hip (p=0.90; Groups: 60.0%, 64.0%, 65.2%) and the knee (p=0.68; Groups: 50.9%, 57.7%, 57.7%).

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 within 30 days.

Conclusion These results suggest that antibiotic administration should not be delayed in hip and knee 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.

809 Extended Oral Antibiotics Increase Bacterial Resistance in Patients who Fail Two-Stage Exchange for Periprosthetic Joint Infection

Authors Laura Certain, Mick Kelly, Brenna Blackburn Jeremy Gililland

Background And Rationale Although recent studies have demonstrated a reduction in the rate of recurrent periprosthetic joint infection (PJI) with administration of prolonged oral antibiotics at time of stage-two reimplantation, the potential for increasing bacterial resistance has not been studied.

Study Question Do prolonged oral antibiotics at the time of second stage reimplantation increase the rate of antibiotic resistance in any subsequent infections? Secondly, does an extended course of oral antibiotics reduce the rate of recurrent PJI?

Methods In this retrospective study, we included patients from 2014 to 2019 who underwent two-stage exchange for chronic PJI. The cohort was stratified based on those who had received at least two weeks of oral antibiotics at the time of stage-two reimplantation compared to those who did not receive antibiotics. The primary outcome was presence of an organism resistant to that oral antibiotic in any subsequent PJI. Positive cultures were classified as resistant organism, sensitive organism, or unknown. The secondary outcome was the overall rate of recurrent PJI in the two groups. Multivariate analyses controlling for demographics and co-morbid conditions were utilized.

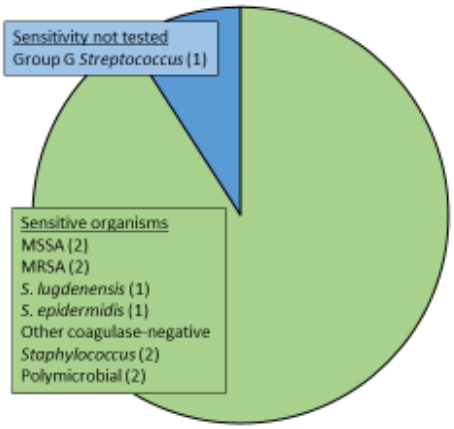
Results Of the 211 patients who underwent two-stage exchange for PJI, 158 patients received oral antibiotics at time of stage two reimplantation. The vast majority received doxycycline. Thirty-five patients had a recurrent PJI. Of those patients, resistant organisms were identified in 16 out of 24 (67%) patients who received antibiotics compared to 0 out of 11 (0%) patients who did not receive antibiotics ($p = 0.0001$). Recurrent PJI was diagnosed in 24 out of 158 (15%) patients who received oral antibiotics compared to 11 out of 53 (21%) patients who did not receive antibiotics ($p = 0.35$).

Figure 1: Microbiology of recurrent PJI in patients who did not receive antibiotics versus patients who received prolonged course of oral antibiotics at stage two reimplantation. Resistance was defined as resistance to the oral antibiotic received (mostly doxycycline), or to doxycycline for the “no antibiotics” group.

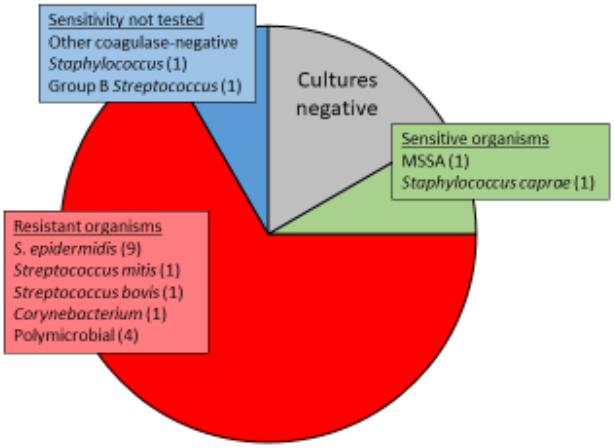
Discussion The treatment of chronic PJI involves significant patient morbidity and presents a challenge to the treating providers. A recent multicenter trial demonstrated significant reduction in recurrent PJI rate in patients who received a three-month oral antibiotic course after the second-stage reimplantation surgery, which led many surgeons to adjust their treatment approach to chronic PJI. However, the study failed to evaluate any increase in bacterial resistance of subsequent PJI. Our study demonstrates that oral antibiotics after two-stage exchange for PJI increases the risk that any subsequent PJI in those patients will be with organisms resistant to the antibiotic used. While we found a non-significant trend toward reduction in the rate of recurrent PJI with the use of prolonged oral antibiotics, we recommend further research in the area to refine antimicrobial protocols as we consider risks and benefits of prolonged antibiotic treatment.

Conclusion Prolonged oral antibiotics following two-stage exchange increases drug resistance to that antibiotic in recurrent PJI, but slightly reduces the overall rate of PJI in our patient cohort.

No antibiotics at Stage Two (N=11)



Antibiotics at Stage Two (N=24)



808 Extended Oral Antibiotic Prophylaxis Does Not Alter Rates of Antimicrobial Resistance in Organisms Causing Periprosthetic Joint Infection Following Primary and Aseptic Revision Total Joint Arthroplasty

Authors Christopher Carender, Poorani Sekar, Kunatum Prasidthrathsint, Nicholas Bedard

Background And Rationale Recently, there have been numerous publications pertaining to the use of extended oral antibiotic prophylaxis in primary and revision total hip arthroplasty (THA) and total knee arthroplasty (TKA). Potential impact of extended oral antibiotic prophylaxis (EOAP) on antimicrobial resistance is poorly understood.

Study Question Does EOAP alter rates of antimicrobial resistance in organisms causing periprosthetic joint infection (PJI) following primary and aseptic revision THA and TKA?

Methods We retrospectively identified all patients who developed PJI following primary or aseptic revision TKA or THA at a single institution from 2009-2020. All patients received standard perioperative intravenous antibiotic prophylaxis. Patients who received at least 7 days of EOAP following surgery were identified. Rates of antimicrobial resistance were compared between standard antibiotic prophylaxis and EOAP cohorts using Fisher's exact test.

Results 135 PJIs were identified in 132 patients; 36% of PJIs received EOAP following their arthroplasty. 68% of PJIs occurred in primary total joint arthroplasty cases. Cephalexin was the most common prophylactic antibiotic prescribed (n=29). Staphylococcus aureus was the most common infecting organism (n=40); 78% of S. aureus isolates were methicillin-sensitive. Rates of antimicrobial resistance are demonstrated in Table 1.

Discussion Rates of antimicrobial resistance were not significantly different between standard antibiotic prophylaxis and EOAP cohorts in all but two instances. Increased resistance to erythromycin and trimethoprim/sulfamethoxazole was observed in coagulase-negative Staphylococci isolates in the EOAP cohort (Table 1). No patients in this group received erythromycin as antibiotic prophylaxis. Trimethoprim-sulfamethoxazole was not used as antibiotic prophylaxis in the four patients in whom there were trimethoprim/sulfamethoxazole resistant isolates. As such, observed differences in antimicrobial resistance are unlikely to be secondary to administration of EOAP.

Conclusion EOAP did not significantly alter rates of antimicrobial resistance in organisms causing PJI following primary and aseptic revision THA and TKA. Additional study is needed with larger cohorts to further evaluate rates of antibiotic resistance following EOAP

Table 1 – Antimicrobial Resistance by Microorganism/Cohort, All Patients

Microorganism/Cohort	Non-susceptible Isolates (n, %)								
	VAN	DOX	ERY	OXA	RIF	SXT	CLI	DAP	LZD
Staphylococcus aureus (n=40)									
EOAP (n=12)	0 (0%)	0 (0%)	4 (33%)	3 (25%)	0 (0%)	0 (0%)	2 (17%)	0 (0%)	0 (0%)
Std (n=28)	0 (0%)	0 (0%)	10 (36%)	6 (21%)	0 (0%)	1 (4%)	3 (11%)	0 (0%)	0 (0%)
p-value	n/a	n/a	1.00	1.00	n/a	1.00	0.63	n/a	n/a
Staphylococcus epidermidis (n=21)									
EOAP (n=9)	0 (0%)	1 (11%)	5 (56%)	8 (89%)	1 (11%)	3 (33%)	1 (11%)	0 (0%)	0 (0%)
Std (n=12)	0 (0%)	0 (0%)	8 (67%)	8 (67%)	0 (0%)	7 (58%)	0 (0%)	0 (0%)	0 (0%)
p-value	n/a	0.43	0.67	0.34	0.43	0.39	0.43	n/a	n/a
Other CoNS (n=21)									
EOAP (n=9)	0 (0%)	1 (11%)	8 (89%)	5 (56%)	0 (0%)	4 (44%)	0 (0%)	0 (0%)	0 (0%)
Std (n=12)	0 (0%)	0 (0%)	2 (17%)	4 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
p-value	n/a	0.43	**<0.01***	0.40	n/a	**0.02***	n/a	n/a	n/a
Corynebacterium spp. (n=6)									
EOAP (n=2)	0 (0%)	2 (100%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)	0 (0%)
Std (n=4)	0 (0%)	1 (25%)	3 (75%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
p-value	n/a	0.40	0.40	n/a	n/a	0.07	n/a	n/a	n/a

	VAN	AMP	STR	GEN
Enterococcus faecalis (n=5)				
EOAP (n=4)	0 (0%)	1 (25%)	2 (50%)	2 (50%)
Std (n=1)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
p-value	n/a	1.00	1.00	1.00

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807 Tourniquet Use Does Not Impact Outcomes in Revision Total Knee Arthroplasty for Periprosthetic Infections

Authors Vinay Aggarwal, Vivek Singh, Joseph Robin, Chelsea Sicat, Katherine Lygrisse, Joshua Rozell, Ran Schwarzkopf

Background And Rationale Given the lack of evidence, there is no recommendation in favor or against the use of tourniquet in revision total knee arthroplasty (rTKA).

Study Question This study aims to investigate whether the use of tourniquet in rTKA for periprosthetic joint infections (PJIs) influences patient outcomes compared to rTKAs for PJI performed without tourniquet use.

Methods We retrospectively reviewed all patients who underwent rTKA for PJI at our institution from 2011-2020. Patients were stratified into two cohorts based on tourniquet inflation during the procedure. Outcomes of interest included estimated blood loss (EBL), change in hemoglobin (Hb), length-of-stay (LOS), 90-day readmission rate, re-revision rate, surgical time, and KOOS, JR scores. Demographic differences were assessed with chi-square and independent sample t-tests. Outcomes were compared using multilinear and logistic regressions, controlling for demographic differences.

Results Of the 247 patients included, 192 (78%) underwent rTKA for PJI with the use of a tourniquet and 55 (22%) did not. Mean tourniquet inflation time for these 192 cases was 97.

45±32.35 minutes with a median of 105.40 minutes. Patients who had a tourniquet inflated during their case had a significantly higher BMI compared to patients who did not (p=0.026). All other demographic variables were statistically similar. Although EBL was significantly greater for patients who did not have a tourniquet used during their procedure (408.03vs.298.97mL;p=0.033), delta changes in Hgb level from pre- to postoperatively did not statistically differ between the two groups (1.70vs.1.67g/dL; p=0.858). LOS (p=0.440), 90-day readmissions (p=0.191), re-revisions (p=0.113), and surgical time (p=0.559) did not significantly differ between the two groups. Both preoperative (p=0.148) and 3-month postoperative (p=0.593) KOOS, JR scores did not statistically differ between the two cohorts. Delta improvement in KOOS, JR scores from baseline to 3-months postoperatively did not statistically differ between the two cohorts (p=0.081).

Discussion Tourniquet use in rTKA for PJI should be evaluated on a case-by-case basis by the operating surgeon. Future studies should aim to elucidate the effects of tourniquet use on functional outcomes after rTKA for PJI at a longer follow-up.

Conclusion Patients undergoing rTKA for PJI achieved similar outcomes irrespective of tourniquet utilization intrao peratively

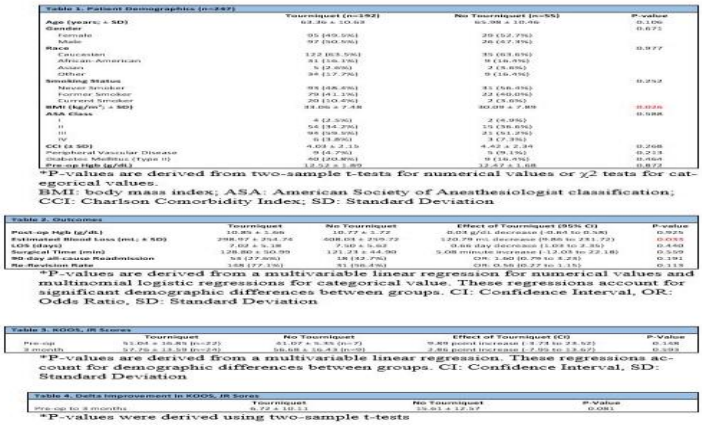

Table 1. Patient Demographics (n=242)	Tourniquet (n=192)	No Tourniquet (n=55)	P-value
Age (years; ± SD)	63.36 ± 10.63	65.98 ± 10.46	0.106
Gender			0.671
Female	95 (49.5%)	29 (52.7%)	
Male	97 (50.5%)	26 (47.3%)	
Race			0.977
Caucasian	122 (63.5%)	35 (63.6%)	
African-American	31 (16.1%)	9 (16.4%)	
Asian	5 (2.6%)	2 (3.6%)	
Other	34 (17.7%)	9 (16.4%)	
Smoking Status			0.253
Never Smoker	93 (48.4%)	31 (56.4%)	
Former Smoker	79 (41.1%)	22 (40.0%)	
Current Smoker	20 (10.4%)	2 (3.6%)	
BMI (kg/m^2; ± SD)	33.06 ± 7.48	30.09 ± 7.89	0.020
ASA Class			0.588
I	4 (2.1%)	2 (6.9%)	
II	54 (34.2%)	15 (36.6%)	
III	96 (59.5%)	21 (51.2%)	
IV	6 (3.8%)	3 (7.3%)	
CCI (± SD)	4.03 ± 2.15	4.42 ± 2.34	0.268
Peripheral Vascular Disease	9 (4.7%)	5 (9.1%)	0.213
Diabetes Mellitus (Type II)	40 (20.8%)	9 (16.4%)	0.464
Pre-op Hgb (g/dL)	12.92 ± 1.89	12.72 ± 1.68	0.472

*P-values are derived from two-sample t-tests for numerical values or $\chi 2$ tests for categorical values.
BMI: body mass index; ASA: American Society of Anesthesiologist classification; CCI: Charlson Comorbidity Index; SD: Standard Deviation

Table 2. Outcomes	Tourniquet	No Tourniquet	Effect of Tourniquet (95% CI)	P-value
Post-op Hgb (g/dL)	10.95 ± 1.66	10.77 ± 1.72	0.03 g/dL decrease (-0.44 to 0.58)	0.925
Estimated Blood Loss (mL; ± SD)	298.97 ± 214.74	408.04 ± 269.72	120.78 mL decrease (6.86 to 231.72)	0.055
LOS (days)	7.02 ± 5.18	7.50 ± 5.63	0.66 day decrease (1.03 to 2.35)	0.440
Surgical Time (min)	128.80 ± 50.99	121.23 ± 44.90	5.08 minute increase (-13.05 to 22.18)	0.559
90-day all-cause Readmission	53 (27.6%)	18 (32.7%)	OR: 1.40 (0.79 to 3.23)	0.191
Re-Revision Rate	14 (7.1%)	5 (10.4%)	OR: 0.55 (0.27 to 1.15)	0.113

*P-values are derived from a multivariable linear regression for numerical values and multinomial logistic regressions for categorical value. These regressions account for significant demographic differences between groups. CI: Confidence Interval, OR: Odds Ratio, SD: Standard Deviation

Table 3. KOOS, JR Scores	Tourniquet	No Tourniquet	Effect of Tourniquet (CI)	P-Value
Pre-op	53.04 ± 16.85 (n=22)	61.07 ± 5.35 (n=7)	9.89 point increase (-3.71 to 23.52)	0.148
3 month	57.26 ± 13.19 (n=24)	56.68 ± 16.43 (n=9)	2.86 point increase (-7.95 to 13.67)	0.593

*P-values are derived from a multivariable linear regression. These regressions account for demographic differences between groups. CI: Confidence Interval, SD: Standard Deviation

Table 4. Delta Improvement in KOOS, JR Scores	Tourniquet	No Tourniquet	P-Value
Pre-op to 3 months	9.72 ± 18.13	15.93 ± 12.57	0.081

*P-values were derived using two-sample t-tests

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806 Tourniquet Use is Associated with Improved Outcomes in Aseptic Revision Total Knee Arthroplasty

Authors Vinay Aggarwal, Vivek Singh, Joseph Robin, Chelsea Sicat, Trevor Simcox, Joshua Rozell, Ran Schwarzkopf

Background And Rationale Although the use of tourniquet in primary total knee arthroplasty (TKA) has been widely studied, the outcomes associated with tourniquet use in revision TKA (rTKA) remains an unexplored area of research.

Study Question This study aims to investigate whether the use of a tourniquet in aseptic rTKA influences surgical outcomes and patient satisfaction compared rTKA performed without a tourniquet.

Methods We retrospectively reviewed all patients who underwent rTKA for all aseptic causes at our institution from 2011-2020. Patients were separated into two cohorts based on tourniquet inflation during the procedure. Outcomes of interest included estimated blood loss (EBL), change in hemoglobin (Hb), length-of-stay (LOS), 90-day readmission rate, re-revision rate, surgical time, and KOOS, JR scores. Demographic differences were assessed with chi-square and independent sample t-tests. Outcomes were compared using multilinear and logistic regressions, controlling for demographic differences.

Results Of the 1,212 patients included, 1,007 (83%) underwent rTKA for aseptic reasons with the use of a tourniquet and 205 (17%) did not. The mean tourniquet inflation time was 93.00±33.29 minutes with a median of 100.00 minutes. EBL was significantly less for patients who had a tourniquet used during their procedure (224.14vs.325.09mL;p<0.001). Patients who had a tourniquet inflated intraoperatively had a significantly lower decrease in Hb from pre- to postoperatively compared to those who did not (1.75vs.2.04g/dL;p<0.001). Although 90-day readmissions did not statistically differ between the two cohorts (p=0.059), re-revision rate was significantly greater for patients who did not have a tourniquet utilized (20.5%vs.15.0%;p=0.038). LOS (p=0.206) and surgical time (p=0.267) did not statistically differ between the two groups. Both preoperative (p=0.107) and 3-month postoperative (p=0.492) KOOS, JR scores did not statistically differ between the two cohorts. Delta improvement in KOOS, JR scores from baseline to 3-months postoperatively did not statistically differ between the two cohorts (p=0.560).

Discussion While delta improvements in KOOS, JR scores were similar for both cohorts, patients who did not have a tourniquet inflated had a larger decrease in Hb, higher EBL, and were more likely to require subsequent re-revision surgery in comparison to patients who did.

Conclusion Surgeons should judiciously consider the use of a tourniquet in rTKA for aseptic causes.

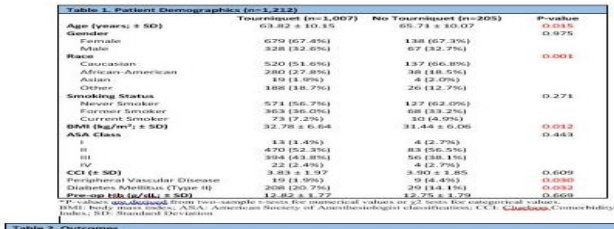


Table 1. Patient Demographics (n=1,212)

	Tourniquet (n=1,007)	No Tourniquet (n=205)	P-value
Age (years; ± SD)	63.82 ± 10.15	65.71 ± 10.07	0.015
Gender			0.975
Female	679 (67.4%)	138 (67.3%)	
Male	328 (32.6%)	67 (32.7%)	
Race			0.001
Caucasian	520 (51.6%)	137 (66.8%)	
African-American	280 (27.8%)	38 (18.5%)	
Asian	19 (1.9%)	4 (2.0%)	
Other	188 (18.7%)	26 (12.7%)	
Smoking Status			0.271
Never Smoker	571 (56.7%)	127 (62.0%)	
Former Smoker	363 (36.0%)	68 (33.2%)	
Current Smoker	73 (7.2%)	10 (4.9%)	
BMI (kg/m²; ± SD)	32.78 ± 6.64	31.44 ± 6.06	0.012
ASA Class			0.443
I	13 (1.4%)	4 (2.7%)	
II	470 (52.3%)	83 (56.5%)	
III	394 (43.8%)	56 (38.1%)	
IV	22 (2.4%)	4 (2.7%)	
CCI (± SD)	3.83 ± 1.97	3.90 ± 1.85	0.609
Peripheral Vascular Disease	19 (1.9%)	9 (4.4%)	0.030
Diabetes Mellitus (Type II)	208 (20.7%)	29 (14.1%)	0.032
Pre-op Hb (g/dL; ± SD)	12.82 ± 1.77	12.75 ± 1.79	0.669

*P-values are derived from two-sample t-tests for numerical values or χ2 tests for categorical values. BMI, body mass index; ASA, American Society of Anesthesiologist classification; CCI, Charlson Comorbidity Index; SD, Standard Deviation

Table 2. Outcomes

	Tourniquet	No Tourniquet	Effect of Tourniquet (95% CI)	P-Value
Post-op Hb (g/dL; ± SD)	11.07 ± 1.68	10.71 ± 1.74	0.31 g/dL increase (0.00 to 0.61)	0.048
Estimated Blood Loss (mL; ± SD)	224.13 ± 179.54	325.09 ± 236.03	110.95 mL decrease (61.74 to 160.16)	<0.001
LOS (days; ± SD)	3.18 ± 1.88	3.33 ± 2.60	0.25 day decrease (0.14 to 0.64)	0.206
Surgical Time (min; ± SD)	124.96 ± 54.43	123.24 ± 60.92	5.66 minute increase (-4.34 to 15.66)	0.267
90-day all-cause Readmission	102 (10.1%)	31 (15.1%)	OR: 1.62 [0.98 to 2.67]	0.059
Re-Revision Rate	151 (15.0%)	42 (20.5%)	OR: 1.60 [1.03 to 2.49]	0.038

*P-values are derived from a multivariable linear regression for numerical values and multinomial logistic regression for categorical value. These regressions account for significant demographic differences between groups. CI: Confidence Interval, OR: Odds Ratio, SD: Standard Deviation

Table 3. PROMs

	Tourniquet	No Tourniquet	Effect of Tourniquet (95% CI)	P-Value
KOOS_JR				
Pre-op (± SD)	43.63 ± 15.49 (n=104)	40.18 ± 15.37 (n=29)	7.52 point increase (-1.67 to 16.71)	0.107
3 month (± SD)	54.14 ± 16.98 (n=158)	52.15 ± 22.37 (n=34)	3.25 point increase (-6.10 to 12.61)	0.492

*P-values are derived from a multivariable linear regression. These regressions account for demographic differences between groups. CI: Confidence Interval, SD: Standard Deviation

Table 4. Delta Changes in KOOS, JR Scores

	Tourniquet	No Tourniquet	P-Value
Pre-op to 3 months (± SD)	10.51 ± 10.36	11.97 ± 13.66	0.560

*P-values were derived using two-sample t-tests

805 Safety and Effectiveness of Intravenous to Oral De-escalation Compared to Continued Vancomycin Therapy in Orthopedic Infections

Authors Chanah Gallagher, Laura Certain, Russell Benefield

Background And Rationale The Oral versus Intravenous Antibiotics for Bone and Joint Infection (OVIVA) trial determined that oral antibiotics administered during the first six weeks of therapy were non-inferior to parenteral antibiotics. There was no difference in the incidence of at least one serious adverse effect.

Study Question What is the impact on safety and effectiveness of de-escalating to oral therapy compared to continuing parenteral vancomycin therapy in patients with orthopedic infections?

Methods We conducted a single-center, retrospective cohort study of patients discharged between April 1, 2018 and April 1, 2020 with an orthopedic infection, a prescription for at least four weeks of parenteral vancomycin, and documented follow-up. The primary outcome was incidence of adverse events defined as provider documentation of the event and changes to therapy. The secondary outcome was incidence of 6-month treatment failure defined as repeat surgical intervention or therapy escalation. Chi-square and the Fisher's Exact Tests were utilized to compare outcomes.

Results One hundred fifty-seven patients were included. The most common indication and isolated organism were prosthetic joint infection (38.9%) and MRSA (38.4%), respectively. Twenty-nine (18.5%) patients were de-escalated to oral therapy. Three (10%) patients in the oral therapy group had an adverse event compared to 35 (27%) in the vancomycin group (p=0.058). Of the 35 patients with an adverse event in the vancomycin group, eight were due to parenteral access-related complications. Treatment failure occurred in 3 (10%) patients in the oral therapy group compared to 27 (21%) patients in the vancomycin group (p=0.29). Three (10%) patients in the oral therapy group had an unplanned readmission compared to 25 (20%) patients in the vancomycin group (p=0.24).

Discussion Patients de-escalated to oral therapy had fewer adverse events and similar incidences of treatment failure compared to patients maintained on parenteral vancomycin. Switching to oral therapy early avoids some adverse events related to parenteral access. Our results in an uncontrolled, real-world setting are consistent with the OVIVA trial.

Conclusion Though limited by sample size, our data indicate that de-escalating to oral therapy in patients with an orthopedic infection improves safety outcomes without compromising effectiveness compared to continued parenteral vancomycin therapy.

Characteristic or Outcome	Oral De-escalation (n=29)	Continued IV Vancomycin (n=128)	P-value
Indication			
Prosthetic Joint Infection, n (%)	6 (21)	55 (43)	0.03
Native Joint Infection, n (%)	7 (24)	7 (5)	0.001
Osteomyelitis, n (%)	11 (38)	35 (27)	0.26
Vertebral Osteomyelitis, n (%)	4 (14)	29 (23)	0.29
Total Duration of Therapy, days, median (IQR)	42 (42-56)	42 (42-56)	0.37
Completed Therapy, n (%)	29 (100)	118 (92)	0.12
Concomitant Antimicrobial, n (%)	16 (55)	63 (49)	0.56
Antibiotic Allergies Present, n (%)	3 (10)	40 (30)	0.02
Unplanned Readmissions, n (%)	3 (10)	25 (20)	0.24
Adverse Reaction, n (%)	0 (0)	11 (8.6)	
Treatment Failure, n (%)	3 (10)	17 (13.3)	
Adverse Reaction, n (%)	3 (10)	35 (27)	0.058
Dermatologic Reaction, n (%)	3 (10)	5 (3.9)	
Worsening Renal Function, n (%)	0 (0)	11 (8.6)	
Parenteral Access-Related Complications, n (%)	---	8 (6.3)	
Treatment Failure, n (%)	3 (10)	27 (21)	0.29

804 A covalently bound surface treatment of methacryloyloxydodecyl pyridinium bromide (MDPB) reduces microbial surface contamination in an ex vivo model while also being safe to the viability of mammalian cells, ex vivo.

Authors Gene Kulesha, Zoe Tamton

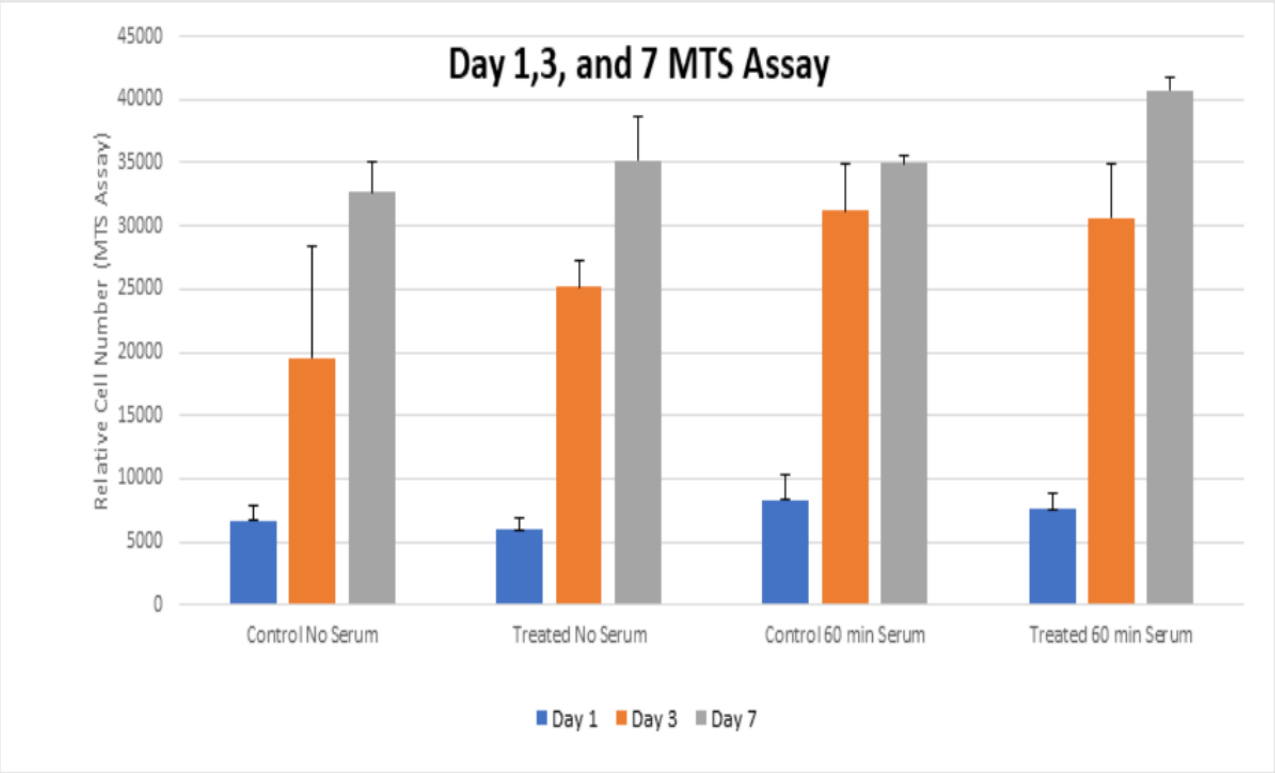
Background And Rationale The operating room remains an unsterile arena with bacteria and other microbes residing in the ambient environment, despite advances in operating room technology. The ability of surgeons and staff to maintain sterility is hampered by the presence of microbes that originate from a variety of sources external to the patient. The microbial contamination of an implant in the operating room, prior to implantation, may lead to deep infection involving the metal implant, which can be devastating. It has been demonstrated in early clinical studies, and more recent pre-clinical studies, that implants inoculated at very low levels of microbes, prior to implantation in various microenvironments, may lead to a deep periprosthetic infection. A covalently bound, non-eluting methacryloyloxydodecyl pyridinium bromide (MDPB) treatment has been developed and applied to cobalt chromium alloy (CoCr) surfaces in order to reduce microbial contamination. Early pre-clinical testing on MDPB treated specimens has demonstrated ex vivo microbial contamination reduction while demonstrating no deleterious effects on mammalian cells, ex vivo.

Study Question As reduction of microbial surface contamination may play an important role in reducing deep periprosthetic infections two fundamental questions must be answered: 1. Does surface treatment with MDPB reduce microbial contamination of a metal implant? 2. Does the surface treatment with MDPB have any negative effects on mammalian cells?

Methods An ex vivo test method based on ASTM E2149 has been developed to determine the ability of the MDPB treatment to reduce microbial contamination of a surrogate CoCr test specimens under dynamic contact conditions. This dynamic shake flask test was developed for routine quality control and screening because classical antimicrobial test methods to evaluate substrate-bound antimicrobials are ineffective in evaluating non-eluting treatments. The method has been modified to allow for evaluation of many different substrate types and microorganisms. Surface antimicrobial activity is determined by quantitatively comparing reduction of bacterial colony forming units on treated samples to untreated samples (controls). This ex vivo test method has been applied to bacterial strains several of which are common to the lower limb orthopedic surgical environment - including Methicillin-sensitive S. aureus (MSSA), Methicillin-resistant S. aureus (MRSA), S. epidermis and E. Coli. An ex vivo test method has been conducted to assess mammalian cell biocompatibility through direct contact of mammalian cells to MDPB treated metal implants. MC3T3 Cells are grown on the surfaces of MDPB treated surrogate CoCr test specimens for specified amounts of time under optimal growth conditions, and then cell viability is quantified using an

MTS assay which measures the mitochondrial activity, which can be correlated to cell number using a standard curve. Relative cell numbers are provided for control and treated surfaces, along with standard deviations. Percent biocompatibility is provided as a relative measure of cellular activity on MPDB treated coupons to control specimens at each time point of 1, 3 and 7 days.

Results Results of the modified ASTM E2149 test demonstrated greater than 90% reduction of Methicillin-sensitive S. aureus (MSSA), Methicillin-resistant S. aureus (MRSA), S. epidermis and E. Coli. on MDPB treated CoCr test specimens as compared to untreated controls. Results of the mammalian cell biocompatibility study using an MTS assay demonstrated no statistically supported difference between MDPB treated specimens as compared to controls. The data trended in the direction of increasing relative cell number for the MDPB treated specimens at several of the timepoints……



803 Function Evaluation of Spherocentric Total Elbows

Authors Gerhard Maale, Nicole Kennard, Aniruth Srinivasaraghavan Arianna Mixon

Background And Rationale Large defects around the elbow can result from trauma, infections and tumors. When there is loss of the olecranon and/or distal humerus, standard hinged prosthesis can have the forearm stems put into the radius, but with high rates of failure. Wear and debris can form secondary to loosening because of attempted pronation-supination and internal-external rotation at the humeral segment and stem. To address this, we used a custom spherocentric designed total elbow prosthesis (Sphero-Elbow) that allows for built-in pronation-supination and internal-external rotation at the humerus.

Study Question What are the short-term functional results of Sphero-Elbow? What is the revision rate? Is it successful in preventing instability/dislocations?

Methods Five patients with Sphero-Elbow were retrospectively reviewed. Four patients were treated after multiple surgeries for infected total elbows and one was for a dislocation and multidirectional instability. They all had no neurologic dysfunction in the hand. They were analyzed for complications, function evaluation using the Musculoskeletal Tumor Society (MSTS), range of motion and usual demographic including time of follow-up with a minimum of 2 years.

Results There were 4 patients with McPherson III-C-3 infected elbows. All these patients required free flaps for coverage. The infected cases were all done as a one-stage. There were 3 females and 2 males. All were considered for amputation, but had functional innervation to the hand. Ages ranged 41-87 with an average of 66 years. All patients were satisfied with their prosthesis. 2 required revisions 5 years after the primary for wear and debris associated with stops of rotation placed at 180° of the Sphero-Elbow. There were 2 patients with flexion contractures of 20 and 30°. MSTS functional evaluation, out of 35, ranged from 15-21 with an average score of 18.

Discussion For patients with severe osteomyelitis or recurrent dislocations, Sphero-Elbow has been successful in preventing amputation and promoting hand function for patients with no neurologic defects to the hand. Patients are able to rotate 180° in supination-pronation and internal-external rotation about the humerus. The patients had long term satisfaction with the prosthesis.

Conclusion Spherocentric total elbow replacements may be an attractive option for patients with massive bone loss about the elbow. The patients were satisfied with their function, relief of pain, and eradication of infection. They are custom appliances and require time consuming IRB's.

802 16S DNA Deep Sequencing in Culture-Negative Periprosthetic Joint Infections with Draining Sinus Tracts

Authors Gerhard Maale, Nicole Kennard, Aniruth Srinivasaraghavan, Arianna Mixon

Background And Rationale Periprosthetic joint infections (PJI) are rare, often severe complications following joint arthroplasty. Traditional culture methods have long been used to identify the presence of organisms in PJI as a gold standard. However, current literature shows culture retrieval rates from 15-60.7% even in draining sinus tracts. Novel bacterial identification methods also suggest that microbes have been underreported and most PJI may be polymicrobial, contrary to past research. Clinicians are looking for more reliable organism identification methods such as Next Generation 16S DNA deep sequencing technologies (NGS) to overcome deficiencies in reporting organisms involved in PJI.

Study Question Can NGS provide more accurate, reliable detection of PJI than traditional culture methods? Are the majority of PJI polymicrobial?

Methods 29 patients were identified with PJI and draining sinus tracts: 18 knees, 6 hips, 1 humerus, 1 shoulder, 1 sacrum, 1 femur, and 1 tibia. All patients had several operations prior to referral and were on antibiotics. All wounds were open and culture negative. Under standardized, sterile conditions, the wound was swabbed and sent for PCR and NGS (MicroGen Dx). The cultures were analyzed for bacteria and fungus.

Results Of 29 culture-negative PJI, NGS identified 47 different bacteria and 1 fungus. PCR showed only single organisms, in 8 patients. NGS found 21 polymicrobial PJI. Ten patients had both gram-positive and gram-negative bacteria represented.

Discussion Our findings indicate that in all 29 patients, culture was not sufficient to detect any bacterial infection in PJI. PCR found only single organisms, in 28% of our patients. NGS identified at least 1 organism in all 29 patients, with an average of 2.97 bacterial species per sample. 72% of the samples were polymicrobial, and 48% demonstrated both gram-positive and gram-negative bacteria. Staphylococcus epidermidis was the most common organism detected in 31% of the patients, and Staphylococcus aureus in 28%.

Conclusion NGS is shown to be more accurate, reliable and provide more in-depth analysis for the detection of microbial and fungal infections. Additionally, because the standard has been traditional culture methods, findings of most PJI to be monomicrobial have most likely been incorrect. Using NGS, the majority of our patients did have polymicrobial PJI. NGS also has utility in identifying antibiotic resistance and guiding more suitable treatment utilizing antibiotic local carriers and systemic antibiotics.

801 Prophylaxis and treatment of infection in complex extremity reconstruction using antibiotic loaded ceramic coated interlocking intramedullary nails

Authors Emilie-Ann Downey, Austin Fragomen, Robert Rozbruch, Asim Makhdom, Kayla Jaime, Taylor Reif

Background And Rationale PMMA antibiotic-coated interlocking intramedullary nails (ACC-IMN) used for long bone osteomyelitis is well supported in the literature. Despite good clinical success, many clinical shortcomings of this technique remain. Synthetic calcium sulfate has emerged as a promising antibiotic carrier that is not as technically demanding to use in combination with a locked intramedullary nail.

Study Question 1.Are antibiotic calcium sulfate coated interlocking intramedullary nails (ACS-IMN) effective at eradicating infection or preventing infection in high risk patients? 2.Are ACS-IMN equivalent to ACC-IMN at eradicated infection?

Methods We retrospectively reviewed the medical records and radiographs of our patients who underwent a limb salvage procedure for infection cure (union or fusion) with ACC-IMN and ACS-IMN for infection prophylaxis or infection cure. We reviewed patient demographics, including host-type, pre-operative infecting organism, intra-operative cultures, and our main outcomes: infection control rate, achievement of union/fusion, limb salvage rate and overall complication rate.

Results Thirty-three patients were treated with ACS-IMN. ACS-IMN was used in 9 patients (27.3%) with goal of infection cure and in 24 patients (72.7%) for infection prophylaxis. In the 24 patients where ACS-IMN was used as infection prophylaxis, there was a 100% (24/24 patients) prevention of infection rate, 90.9% union rate (20/22 patients) and 100% (24/24 patients) limb salvage rate. Nine patients were treated with ACS-IMN to eradicate infection and were compared to a cohort of twenty-eight patients treated with ACC-IMN. The infection was eradicated in 7/9 patients (77.8%) in the ACS-IMN group versus 21/26 patients (80%) in the in ACC-IMN group($p=0.44$). Bone union/fusion was achieved in 8/9 patients (88.9%) in the ACS-IMN group versus 21/24 patients (87.5%) in the ACC-IMN group ($p=0.11$). The limb salvage rate in the ACS-IMN group was 100% (9/9 patients) versus 89% (25/28 patients) in the ACC-IMN group.

Discussion It appears that ACS-IMN results are promising and could be comparable to ACC-IMN for treatment of long bone osteomyelitis. Future studies with larger cohorts of patients are required to confirm these expectations.

Conclusion ACS-IMN is a safe and effective technique for long bone infection prophylaxis or cure in the context of complex lower extremity reconstruction

800 Topical vancomycin and tobramycin powder for infection prophylaxis in orthopaedic trauma surgery: Economically justifiable?

Authors Gregory Kirchner, Matthew Garner, Nathan Smith, Raymond Kim, Shawn Hines

Background And Rationale There is increasing interest regarding the risks and benefits of topical antibiotics applied directly to surgical wounds for the prevention of infection following orthopaedic trauma surgery.

Study Question Is the prophylactic use of vancomycin powder, tobramycin powder, and vanomycin and tobramycin powders combined economically justified in orthopaedic trauma surgery?

Methods The cost of vancomycin and tobramycin powders, infection rates and costs of treating surgical site infections were obtained from our institution's records and existing literature. A break-even analysis was then performed using vancomycin powder only, tobramycin powder only, and combined vancomycin and tobramycin powders to determine the respective absolute risk reduction (ARR) in infection rate needed to make the prophylactic application of each therapy type break-even.

Results At our institutional pricing of $20.64 and $75.80 for 1g vancomycin and 1.2g tobramycin, respectively, use of each individually would be economically justified if it reduced an average infection rate of 4.3% by an ARR of 0.02% and 0.07%, respectively. Used in combination for $90.66, the ARR was 0.09%. Varying cost of treating infection from $5,000-$200,000 while maintaining cost of antibiotic powder at $90.66 demonstrated a range in ARR from 1.93% to 0.05%, respectively. At the same cost of $90.66 but varying infection rate from 1% to 25% did not affect ARR, which was constant at 0.09%.

Discussion Vancomycin and tobramycin powders are economically justifiable when used alone or in combination. The economic model used can be easily adaptable to any surgeon's practice to determine cost-effectiveness with data from their own practice.

Conclusion Considering the cost of vancomycin and tobramycin powder at our institution, the application of these powders, whether independently or in combination, appear to be economically justifiable for infection prevention in ort hopaedic trauma surgery.

Figure 1. Equation used to calculate break-even infection rate

$$S_{total} \times C_t \times IR_i = (S_{total} \times C_p) + (S_{total} \times C_t \times IR_f)$$

Solving for IR_f yields:

$$IR_f = \frac{(IR_i \times C_t) - C_p}{C_t}$$

Where: S_{total} = total annual surgeries; C_t = total cost of treating an infection; C_p = cost of protocol; IR_i = initial infection rate; IR_f = breakeven infection rate.
Adapted from Hatch MD, Daniels SD, Glerum KM, Higgins LD. The cost effectiveness of vancomycin for preventing infections after shoulder arthroplasty: a break-even analysis. *J Shoulder Elbow Surg.* 2017;26(3):472-477.

799 When Should We Change Gloves? Surgical Gloves Have High Contamination Rates

Authors Leanne Ludwick, Emanuele Chisari, Maxwell Courtney, Javad Parvizi, Chad Krueger

Background And Rationale Many joint replacement surgeons double-glove and change them frequently to minimize intraoperative contamination and lower the risk of periprosthetic joint infection (PJI). However, there is limited data on how gloves are contaminated during primary and revision arthroplasty and no precise protocol exists to direct surgeons on when to change their gloves.

Study Question The goal of this study was to evaluate the contamination of gloves during infected total joint arthroplasty (TJA) cases to guide future studies on glove changing protocols.

Methods We performed cultures and next-generation sequencing (NGS) on 25 infected revision cases and 10 primary arthroplasty cases. Samples were taken from surgeon outer gloves every 20 minutes from the start of the surgery until the joint was irrigated prior to trialing. To evaluate cross-contamination during infected cases, we sampled gloves using blood agar plates. In primary cases, culture swabs of chamber cuts and sterile instruments on the back table were used as negative controls.

Results In the primary cases, all cultures were negative and only 3 (8.1%) of the 37 samples were found to be NGS positive with bacteria that were considered contaminants. In the infected cases, 30 (48.4%) samples yielded positive microbial results. The most commonly isolated organisms were Staphylococcus aureus (n=16), Staphylococcus epidermidis (n=11), and Enterococcus faecalis (n=7). A positive culture on the glove was more likely to occur after the arthrotomy was performed than before (70% vs. 40%).

Discussion Surgical gloves are a common source of cross-contamination in the intraoperative field, especially in infected arthroplasty cases. A higher rate of glove contamination following the opening of the joint, the arthrotomy may allow for bacterial spread of bacteria across the operative site.

Conclusion While further clinical study is needed, surgeons should consider performing a thorough irrigation of the joint and changing gloves immediately following arthrotomy in infected cases.

798 Treatment of periprosthetic joint infection with the engineered antimicrobial peptide PLG0206 using a large animal model

Authors Kimberly Brothers, Jonathan Mandell, Masashi Taguchi, Dana Parker, Peter Alexander, Kenneth Urish

Background And 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 biofilm. Cationic amphipathic peptides (CAPs) are antimicrobial peptides that serve as an alternative therapeutic strategy for treatment of recalcitrant bacterial biofilm. The use of natural CAPs has been limited in the clinic due to suboptimal efficacy and systemic toxicity. These limitations motivated the design of a synthetic engineered cationic amphipathic peptide, PLG0206.

Study Question The novelty of using PLG0206 during the direct irrigation and debridement of infected implants led our group to investigate local treatment of S. aureus biofilms in a periprosthetic joint infection (PJI) rabbit model.

Methods A rabbit PJI model was used where a Kirschner wire tibial implant was placed into the proximal tibia. After closure of the joint space, Staphylococcus aureus was injected into the intra-articular space and a mature biofilm was allowed to develop. At 2 days post infection, the joint space was reopened irrigated, debrided, and treated with PLG0206 at different time intervals and concentrations. The implant and part of the proximal tibia were removed by sterile manipulation and CFU analysis was performed.

Results Implants removed at 2 days post infection and treated with 1 mg/ml PLG0206 for 15 minutes had a significant reduction in bacterial biofilm burden, over 100-fold (horizontal dashed line) (*p=0.047), compared to I&D alone implants (Fig 1A). An increase in biofilm bacterial burden was observed in implants treated at decreased times and peptide concentrations. In the survival study, rabbits were treated with cefazolin, PLG0206, or both. I&D alone rabbits all succumbed to infection within 4 days post infection (Fig 1B). Rabbits treated with PLG0206 only survived slightly longer but still displayed 0% survival by 8 days post infection. Cefazolin treated rabbits, ending at 7 days post infection (Fig 1B, vertical dashed line), had 0% survival by 14 days post infection. Rabbits which received combination treatment of systemic cefazolin and PLG0206 had 63% survival at 28 days post infection.

Discussion In the short term in vivo experiments PLG0206 significantly reduced bacterial burden. However, in the longer survival study PLG0206 treatment alone was only sufficient to prolong animal life for an additional 4 days. Cefazolin treated rabbits survived longer than both I&D alone and PLG0206 treated animals. Combination therapy of PLG0206 with Cefazolin was the most successful with 63% rabbits surviving out to 28 days post infection.

Conclusion In a large animal model of S. aureus PJI with 100% mortality when antibiotics are discontinued, we have demonstrated adjuvant care with PLG0206, a new class of broad-spectrum antimicrobials, has high activity against biofilm and results in disease free survival.

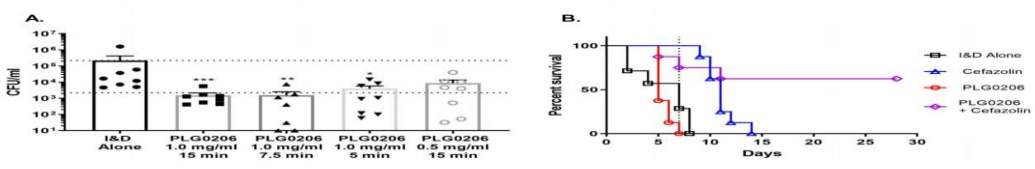


Figure 1
A. *In vivo* intra-articular treatment of PJI with PLG0206 for 15 minutes clear *S. aureus* biofilms *p<0.05 **p<0.01 ***p<0.001
B. Treatment with cefazolin systemically and PLG0206 intraoperatively results in increased survival

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797 Contact with Blood Does not Affect Bactericidal Properties of Povidone-Iodine

Authors Ilan Small, Emanuele Chisari, Chad Krueger, Javad Parvizi

Background And Rationale Povidone-iodine (PVP-I) solutions are widely used for wound irrigation and prevention of periprosthetic joint infections. Several authorities state that the bactericidal effect of PVP-I is reduced upon contact with blood, although this remains a matter of debate.

Study Question The purpose of this in vitro study was to determine the bactericidal efficacy of different concentrations of PVP-I when exposed to blood.

Methods Blood was obtained from 30 patients undergoing primary or aseptic revision total knee or total hip arthroplasty. Breakpoint experiments were performed using Methicillin-resistant Staphylococcus aureus (MRSA), Methicillin-sensitive Staphylococcus aureus (MSSA), and Escherichia coli (E. Coli). 105 colony-forming units (CFU) of each bacterium were incubated with PVP-I 0.5% diluted by saline or blood in 1mL:10 mL, 1mL:100 mL, and 1mL:1000 mL ratios, undiluted PVP-I, undiluted isopropyl alcohol (IPA), or undiluted saline. PVP-I and blood or PVP-I and saline were mixed for 1 or 2-minutes and then plated with each bacteria strain. CFUs were measured after 24 hours and each experiment was repeated in triplicates. Linear mixed models were used to analyze bactericidal efficacy, defined as 100-100*final CFUs/initial CFUs as mean and standard error.

Results Results are summarized in Table I.

Discussion PVP-I dilutions of 1:100 and 1:1000 showed the same antibacterial properties as undiluted PVP-I, which had an efficacy of 100%. However, dilution of PVP-I to a 1:10 ratio resulting in an effective concentration of 0.05% PVP-I caused a significant reduction in its antibacterial properties. The efficacy rate was for the 1:10 blood dilution compared to the 1:100, 1:1000, undiluted PVP-I, or undiluted IPA dilutions was (mean ± standard error) 52.9% ± 4.6% ($p < 0.001$) for MRSA, 56.0 ± 4.6% ($p < 0.001$) for MSSA, and 49.2% ± 5.0% ($p < 0.001$) for E. Coli. The efficacy of the same solutions after 2-minutes was similar and not statistically significantly different. For all dilutions, increasing length of exposure to blood was not statistically significant when accounting for multiple testing.

Conclusion The results of this in vitro study demonstrated that contact with blood does not eliminate the anti-bacterial properties of PVP-I, as long as the concentration of effective PVP-I remains relatively high. In our experiments, dropping the PVP-I concentration to 0.05% resulted in loss of most of its antibacterial properties.

Solution	MRSA 1 Minute Efficacy	MRSA 2 Minute Efficacy	MSSA 1 Minute Efficacy	MSSA 2 Minute Efficacy	E. Coli 1 Minute Efficacy	E. Coli 2 Minute Efficacy
1:10 PVP-I	52.9% ± 4.6%	60.1% ± 4.2%	56.0 ± 4.6%	61.8% ± 4.3%	49.2% ± 5.0%	50.8 ± 5.3%
1:100 PVP-I	100% ± 0	100% ± 0	99.9% ± 0%	99.6% ± 0.2%	100% ± 0%	100% ± 0%
1:1000 PVP-I	100% ± 0	100% ± 0	100% ± 0%	100% ± 0%	100% ± 0%	99.5% ± 0.3%
1:10 Saline	99.9% ± 67	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0
1:100 Saline	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0
1:1000 Saline	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0
Undiluted PVP-I	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0
Undiluted IPA	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0	100% ± 0

796 History of COVID-19 Was Not Associated with Length of Stay or In-Hospital Complications After Elective Lower Extremity Joint Replacement

Authors Andy O Miller, Anna Jungwirth-Wienberger, Friedrich Boettner, Milan Kapadia, Alioune Diane, Yu-Fen Chiu, Stephen Lyman, Mark Fontana

Background And Rationale The impact of previous infection with the novel coronavirus, SARS-CoV-2, on the morbidity of elective total joint replacement is not fully understood. This study from a large orthopedic specialty hospital reports on the association between SARS-CoV-2 infection (COVID-19 disease) and hospital course (length of stay) and in-hospital complication rates of undergoing elective primary joint replacement.

Study Question Is a history of SARS-CoV-2 infection associated with increased morbidity or increasing risk of complications after total joint arthroplasty?

Methods Demographics, comorbidities, length of stay, and in-hospital complications of 5,354 consecutive patients undergoing elective primary total joint arthroplasty (TJA) were described, comparing 340 patients with history of COVID-19 to 5,014 patients without history of infection. History of COVID-19 was defined with either a positive RT-PCR test or a positive IgG antibody test for SARS-CoV-2. All patients were given both types of tests prior to surgery.

Results A higher proportion of patients with history of COVID-19 were obese compared to patients without history of COVID-19 (43.8% vs. 32.4%, $p < 0.001$). Also, higher proportion of patients with history of COVID-19 were Black (15.6% vs. 6.8%, $p < 0.001$) or Hispanic (8.5% vs. 5.4%, $p = 0.028$). Among the 340 patients with history of COVID-19, 23 (6.8%) reported inpatient COVID-19 treatment. With respect to their elective inpatient joint replacement, those with history of COVID-19 did not have a significantly longer median length of stay after controlling for other factors (for hip replacements, median 2.9 hours longer, 95% CI -2.0 to 7.8, p=0.240; for knee replacements, median 4.1 hours longer, 95% CI -2.4 to 10.5, p=0.214). A higher percentage of history of COVID-19 patients were discharged to a post-acute care facility (4.7% vs. 1.9%, p=0.001). There was no significant difference in in-hospital complication rates between the two study groups (0/340=0.0% versus 22/5,014= 0.44%, $p = 0.221$).

Discussion Patients with and without a history of COVID-19 did not differ in LOS or in-hospital complication rates after elective inpatient primary arthroplasty.

Conclusion In a large single center cohort of primary arthroplasty patients, no differences in median length of stay or likelihood of an in-hospital complication were observed among those patients with and without a history of COVID-19. However, larger cohorts and longer observation times are required to confirm our findings.

795 Culture Negative PJI: Signs & Biomarkers to Guide Diagnosis

Authors Leanne Ludwick, Emanuele Chisari, Kira Smith, Javad Parvizi

Background And Rationale The diagnosis and treatment of culture negative (CN) periprosthetic joint infection (PJI) remains challenging. The goal of our study was to identify potential differences between the clinical presentation of CN and culture positive (CP) PJI to guide the future diagnosis of CN PJI.

Study Question What are the potential differences between the clinical presentation of culture negative and culture positive periprosthetic joint infection?

Methods We retrospectively reviewed 1129 patients diagnosed with PJI using 2018 ICM criteria. 933 patients presented with CP PJI, while 217 were CN. Additionally, 714 of these infections were chronic, while 415 were acute. Clinical notes and laboratory reports were reviewed. Statistical analysis consisted of descriptive statistics, and multiple hypothesis testing to compare CN versus CP cases. Primary endpoints were biomarkers levels and clinical signs of infection.

Results Serum biomarker levels of chronic PJI did not differ among CN and CP. In acute cases, serum CRP (10.3 vs 14.4, $p<0.001$) and ESR (67.2 vs. 77.0, $p=0.021$) were lower in the CN group, while serum WBC was not. Synovial WBC count (39950 vs. 70497, $p=0.001$) and neutrophil percentage (81.0% vs. 86.7%, $p=0.024$) were lower in chronic CN PJI. Neutrophil percentage (73.5% vs. 84.1%, $p=0.014$) was also lower for acute CN PJI. Overall, intra-operative purulence incidence was higher in CP PJI (63.7% vs 25.0%, $p<0.001$), while the incidence of sinus tracts was higher in CN PJI (34.4% vs 21.7%, $p<0.001$). Both acute and chronic CN PJI had a higher one-year success rate than CP PJI (77.6% vs. 64.2%, $p=0.003$ and 75.41% vs. 61.0%, $p=0.009$).

Discussion CN PJI seems to be associated with similar levels of serum biomarkers, but lower levels of synovial biomarkers. Additionally, they are more likely to present with a sinus tract than CP PJI, exhibiting the severity and subtle course of CN infections.

Conclusion Our findings demonstrate that it is important to do a thorough infection workup to ensure that PJI patients with lower biomarkers of infection and negative cultures are not overlooked.

794 Systemic Sepsis Secondary to Acute Periprosthetic Joint Infection: Incidence, Risk Factors and Outcomes of Treatment

Authors Leanne Ludwick, Noam Shohat, Matthew Sherman, Sydney Streicher, Javad Parvizi

Background And Rationale Periprosthetic joint infection (PJI) can lead to a severe systemic inflammatory response and may result in systemic sepsis. There is little data on how often systemic sepsis may occur in patients with PJI and whether the general sepsis influences the prognosis of treatment.

Study Question What is the incidence of PJI-related sepsis, the risk factors for developing sepsis, and does systemic sepsis influence the outcome of surgical treatment?

Methods We retrospectively reviewed the charts of 255 patients who presented with an acute or acute hematogenous PJI and underwent a debridement, antibiotic, and implant retention procedure (DAIR). Sepsis was defined by systemic inflammatory response syndrome (SIRS) criteria or bacteria-positive blood cultures. Patients with other sources of infection were excluded (n=18). Our final cohort consisted of 237 patients. Statistical analysis consisted of univariate analysis, logistic regression, and AUC predictive curves.

Results Of the 237 patients in our cohort, 103 (43.7%) patients met sepsis criteria. These patients presented to the hospital with elevated vital signs, as well as elevated levels of serum C-reactive protein (CRP) (19.9 mg/L, $p<0.001$) and white blood cell (WBC) count (13,803/ul, $p<0.001$). Regression revealed serum CRP and the male gender to be risk factors for developing systemic sepsis ($p<0.001$ and $p=0.04$, respectively). Septic patients demonstrated higher readmission rate (23.5%, $p=0.021$) and decreased treatment success (51.5%) compared to non-septic patients (66.9%, $p=0.02$). Regression identified serum CRP and number of previous surgeries on the infected joint to be risk factors for treatment failure in septic patients ($p=0.009$ and $p=0.01$, respectively).

Discussion Systemic sepsis secondary to acute PJI is not a rare occurrence. Systemic sepsis appears to result in protracted postoperative course and compromise of the surgical treatment.

Conclusion This study, first of its kind as far as we are aware, evaluates the incidence and impact of systemic sepsis. Recognition of this not uncommon problem may allow for design of better studies to prevent systemic sepsis development in the first instance or allow for implementation of strategies that can minimize its adverse impact in patients with acute PJI.

793 Autofluorescence Digital Imaging for Diagnosing Chronic Wound Infections: Preliminary Case Series

Authors James Stiehl

Background And Rationale Evolving digital technologies allow for new capabilities to diagnose chronic wound infections. One such system utilizes autofluorescence of bacterial porphyrins to determine the presence of bacteria in chronic wounds leading to strategic decisions.

Study Question What are relevant applications of this technology and how can the practicing surgeon utilize this information for strategic clinical decisions including surgical intervention, antibiotic treatments, and wound healing options.

Methods Recently, we added a new system for imaging (MolecuLight, Toronto, CA) which is a digital camera combined with a device that shines a violet light (405 nanometers) onto the wound giving clear evidence for bacterial bioburden.. From an investigational review board study that was assessing the effect of wound irrigation on recalcitrant chronic wounds, a case series of 5 patients was collected from 9 patients where autofluorescence imaging offered unique diagnostic opportunities. Each case demonstrated significant red or cyan color which indicates bacterial contamination at a minimum level of log 4 colony forming units/ gram of tissues.

Results Four patients had difficult pelvic pressure wounds being treated for chronic wound infection involving the sacrum, greater trochanter and ischial tuberosity. One patient had a difficult pressure injury with exposed sacral bone, required daily pulsatile irrigation to keep the wound clean enough for secondary intention healing to occur. One patient was diagnosed with an ischial abscess based on the imaging study leading to thorough debridement to stabilize the wound. Two patients had difficult wounds that were determined clean and healing with no imaged bacteria with follow-up studies. One patient had moderate sero-sanguinous fluid from a trochanteric wound that imaged red consistent with >log 4 CFU/ml and this patient proved to have a deep periprosthetic joint infection

Discussion Prior experimental studies with the MolecuLight have shown a minimum sensitive of log 2 CFU/gm of tissue and a positive predictive value of 100% for bacterial bioburden greater than log 4 CFU/gm of tissue. The literature suggests that wound contamination over log 4-5 CFU/gm are high enough to result in chronic infection. This information can be utilized for determining treatment options. For the practicing surgeon, there is no more guesswork required for assessing the bacteria bioburden contaminating a wound.

Conclusion Autofluorescence imaging offers a technological advance for common wound management providing the surgeon with an accurate assessment of bioburden that exists on any wound. Additionally this allows for titration of treatment such as wound closure, wound debridement, and antiseptic bacterial control, reflecting patient immune competence.

792 Rapid synovial fluid-induced aggregation of Staphylococcus aureus occurs across clinical isolates and is mechanistically independent of biofilm formation

Authors Amelia Staats, Peter Burback, Paul Stoodley, Kenneth Urish, Mostafa Eltobgy

Background And Rationale Synovial fluid has recently been reported to stimulate the rapid formation of bacterial aggregates upon contact (Figure 1). Staphylococcal aggregates are highly recalcitrant to antibiotic challenge and neutrophil-mediated clearance, rendering early aggregation during infection a potentially potent virulence factor.

Study Question Based on the pathogenic implications of aggregate formation, we first sought to evaluate whether all S. aureus strains have the capacity to aggregate in synovial fluid, or if the phenotype is PJI isolate-specific. As blood will co-occupy a surgical joint, we also assessed aggregation in human serum and a mixture of both host fluids together. Finally, we explored whether surface-associated biofilm formation correlates with synovial fluid-induced aggregation.

Methods To quantify aggregation, we used a flow cytometry-based method in conjunction with microscopy. Aggregation of 10 PJI clinical isolates and 11 septicemia isolates was evaluated following a 1-hour incubation in bovine synovial fluid, human serum, or a combination treatment. A conventional crystal violet assay was then employed to quantify biofilm formation of the same isolates with and without the host fluid supplementation.

Results All of the strains were stimulated to aggregate upon synovial fluid exposure regardless of source, however, PJI isolates aggregated significantly more than septicemia isolates. Additionally, all isolates aggregated in human serum but to a lesser extent. We found considerable variation in biofilm formation between isolates, but overall no correlation between biofilm-forming capacity and synovial fluid-induced aggregation.

Discussion The lack of strain-specificity suggests a wide range of pathogens are capable of aggregating in synovial fluid. An overall higher aggregation phenotype in PJI isolates compared to septicemia indicates there may be genotypic differences between the groups. Furthermore, the lack of correlation between biofilm formation and synovial fluid-induced aggregation indicates there are likely distinct mechanisms orchestrating the two processes.

Conclusion Through this work, we report synovial fluid-induced aggregation occurs across clinical isolates, regardless of infection source. It appears to be independent of attached biofilm formation and impacted by PJI isolate-specific factors.

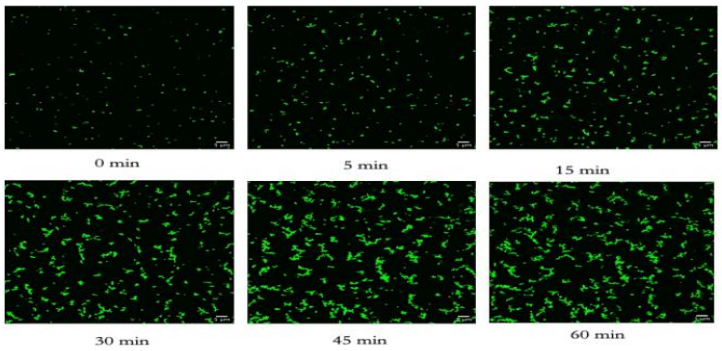

Figure 1. 1-hour timelapse imaging of aggregation in bovine synovial fluid using confocal microscopy. GFP-expressing *S. aureus* strain AH1726 aggregation following 0, 5, 15, 30, 45, and 60 minutes of incubation in 10% bovine synovial fluid in Ringer's solution.

791 Synovial fluid-induced aggregation of Staphylococcus aureus inhibits neutrophil production of reactive oxygen species (ROS)

Authors Amelia Staats, Paul Stoodley, Peter Burback

Background And Rationale The rapid recruitment of neutrophils is essential for controlling staphylococcal joint infections. Recent works show that Staphylococcus aureus aggregate formation impairs neutrophil phagocytic activity. Synovial fluid-induced aggregation occurs rapidly upon contact with synovial fluid, yielding aggregates larger than 15µm within minutes. Furthermore, the degree of aggregation is enhanced by dynamic incubation in synovial fluid as would be found in a native joint. It is therefore important to understand the impact such aggregates have on mechanisms of neutrophil-mediated clearance.

Study Question The production of reactive oxygen species (ROS) is a hallmark of efficacious neutrophil phagocytosis and bactericidal activity. We sought to examine the influence of synovial fluid-induced aggregate formation on neutrophil response by quantifying ROS production. Furthermore, the effects of synovial fluid and aggregate size were evaluated as independent variables.

Methods Neutrophils were isolated from the blood of a healthy donor and S. aureus was opsonized in human serum prior to a 1-hour incubation in bovine synovial fluid. Neutrophils were added to the aggregates or untreated cells at an MOI of 10:1 and ROS production quantified for 1 hour. To control for synovial fluid concentration whilst manipulating aggregate size, we repeated the assay following both dynamic and stagnant incubations in synovial fluid.

Results Compared to single cells, staphylococcal aggregates inhibited neutrophil ROS production over the course of a 1-hour challenge. Furthermore, as the concentration of synovial fluid in the system was increased, ROS production against the bacteria decreased dose-dependently. We observed a greater burst inhibition against larger aggregates, which were incubated in synovial fluid dynamically, compared to stagnantly incubated smaller aggregates.

Discussion Neutrophil ROS production was inhibited against aggregates, likely due to a size-inhibition of phagocytosis and a skewed neutrophil fate. This inhibition was exacerbated by the generation of larger aggregates through dynamic incubation, indicating that aggregate size plays a role in the observed effect, independent of synovial fluid concentration.

Conclusion In conclusion, synovial fluid-induced aggregate formation impairs an essential neutrophil response, potentially aiding in the progression of chronic infection.

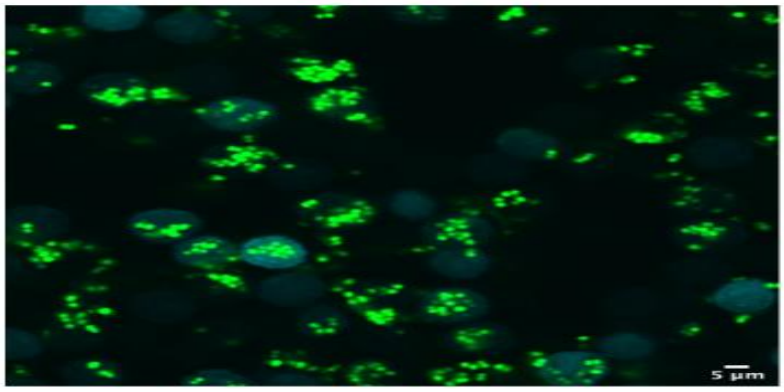

Figure 1. Confocal microscopy of green fluorescent protein labelled synovial fluid-induced aggregates (green) and human neutrophils (blue).

DISCLOSURES

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Johnson & Johnson: Stock or stock Options

Ju, Minseon: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Jungwirth-Weinberger, Anna: (This individual reported nothing to disclose); Submitted on: 05/27/2021.

K

Kanhere, Arun: (This individual reported nothing to disclose); Submitted on: 02/04/2021

Kapadia, Milan: (This individual reported nothing to disclose); Submitted on: 06/02/2021

Kelley, Benjamin: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Kelly, Mick: (This individual reported nothing to disclose); Submitted on: 06/02/2021

Kennard, Nicole: (This individual reported nothing to disclose); Submitted on: 06/08/2021

Khilnani, Tyler: Submitted on: 05/29/2021
American Board of Venous and Lymphatic Medicine: Board or committee member
Foundation for Venous and Lymphatic Medicine: Board or committee member
Medtronic: Paid presenter or speaker
Phlebology: The Journal of Venous Disease

Kim, Kiryung: (This individual reported nothing to disclose); Submitted on: 06/04/2021

Kim, Raymond: (This individual reported nothing to disclose); Submitted on: 05/31/2021

Kirchner, Gregory: (This individual reported nothing to disclose); Submitted on: 06/09/2021

Kirschner, Noah: (This individual reported nothing to disclose); Submitted on: 05/31/2021

Kittaka, Mizuho: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Klika, Alison: (This individual reported nothing to disclose); Submitted on: 06/10/2021

Krueger, Chad: Submitted on: 05/04/2021
AAOS: Board or committee member
American Association of Hip and Knee Surgeons: Board or committee member
Journal of Arthroplasty: Editorial or governing board

Kulesha, Gene: Submitted on: 06/09/2021
Onkos Surgical: Employee

L

Lang, Amanda: (This individual reported nothing to disclose); Submitted on: 06/03/2021

Lao, Nicole: (This individual reported nothing to disclose); Submitted on: 06/09/2021

Laycock, Phillip: Submitted on: 07/18/2021
Biocomposites Ltd: Employee

Le, Michael: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Levack, Ashley: (This individual reported nothing to disclose); Submitted on: 02/03/2021

Li, Anthony: (This individual reported nothing to disclose); Submitted on: 06/03/2021

Li, Alan: (This individual reported nothing to disclose); Submitted on: 05/12/2021

Liporace, Frank: Submitted on: 05/07/2021
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

Long, William: Submitted on: 11/12/2020
Total Joint Orthopedics: Paid consultant
Zimmer: IP royalties

Ludwick, Leanne: (This individual reported nothing to disclose); Submitted on: 06/04/2021

Luo, Tianyi: (This individual reported nothing to disclose); Submitted on: 04/01/2020

Lygrisse, Katherine: (This individual reported nothing to disclose); Submitted on: 03/03/2021

Lyman, Stephen: Submitted on: 06/02/2021
Corin U.S.A.: Paid consultant
HSS Journal: Editorial or governing board
International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine: Board or committee member
ISAKOS Journal (new journal): Editorial or governing board

Lyons, Madeline: (This individual reported nothing to disclose); Submitted on: 04/14/2021

M

Maale, Gerhard: Submitted on: 06/08/2021
Biocomposites: Paid consultant
Link Orthopaedics: Paid consultant
Onkos: Paid consultant
Smith & Nephew: IP royalties

Makhdom, Asim: (This individual reported nothing to disclose); Submitted on: 04/12/2021

Mamouei, Zeinab: (This individual reported nothing to disclose); Submitted on: 05/31/2021

Mandl, Lisa: Submitted on: 05/27/2021
American College of Rheumatology: Board or committee member
Annals of internal Medicine: Editorial or governing board
Up-To-Date: Publishing royalties, financial or material support

McLaren, Alexander C: Submitted on: 06/07/2021
Hayes Diagnostics Inc: Stock or stock Options
Journal of Bone and Joint Infection: Editorial or governing board
Musculoskeletal Infection Society: Board or committee member

Sonoran Biosciences: Stock or stock Options

Matthews, John: Submitted on: 06/01/2021
Johnson & Johnson: Stock or stock Options

Mehta, Samir: Submitted on: 10/01/2020
Acumed, LLC: Research support
AO Foundation: Board or committee member
Bioventus: Paid presenter or speaker
Current Opinion in Orthopaedics: Editorial or governing board
DePuy, A Johnson & Johnson Company: Paid presenter or speaker

Mehta, Bella: Submitted on: 10/07/2020
Norvartis: Paid consultant

Menken, Luke: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Miell, Kelly: (This individual reported nothing to disclose); Submitted on: 06/05/2021

Milbrandt, Nathalie: (This individual reported nothing to disclose); Submitted on: 06/04/2021

Miller, Andy: Submitted on: 02/03/2021
BoneSupport: Paid consultant

Mironenko, Christine: (This individual reported nothing to disclose); Submitted on: 10/12/2020

Mirza, Serene: (This individual reported nothing to disclose); Submitted on: 07/18/2021

Mixon, Arianna Donette: (This individual reported nothing to disclose); Submitted on: 06/08/2021

Molloy, Robert: Submitted on: 07/08/2021
American Association of Hip and Knee Surgeons: Board or committee member
Stryker: Paid consultant; Paid presenter or speaker; Research support
Zimmer: Research support

Moore, Kelly: (This individual reported nothing to disclose); Submitted on: 06/03/2021

N

Nair, Rajeshwari: Submitted on: 07/21/2021
Johnson & Johnson: Employee

Nana, Arvind: Submitted on: 07/20/2021
AAOS: Board or committee member
Bone Foam: IP royalties

Natoli, Roman: (This individual reported nothing to disclose); Submitted on: 04/02/2021

Nelson, Sandra Bliss: Submitted on: 04/01/2021
UpToDate: Publishing royalties, financial or material support

Nguyen, Vincent: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Nishimura, Ichiro: Submitted on: 06/04/2021
Applied Biomedical Research, LLC: Board or committee member
BioVinc LLC: Unpaid consultant
FUJIFILM: Paid consultant
SINTX Technologies: Research support

Nishtala, Sita Nirupama: (This individual reported nothing to disclose); Submitted on: 06/07/2021

Nocon, Allina: (This individual reported nothing to disclose); Submitted on: 05/27/2021

O

Odum, Susan: Submitted on: 06/01/2021
AAOS: Board or committee member
American Joint Replacement Registry: Paid consultant

Olsen, Adam: (This individual reported nothing to disclose); Submitted on: 06/06/2021

Ong, Christian: (This individual reported nothing to disclose); Submitted on: 02/03/2021

Osmon, Douglas: (This individual reported nothing to disclose); Submitted on: 05/27/2021

Otero, Jesse: Submitted on: 05/28/2021
American Association of Hip and Knee Surgeons: Board or committee member
DePuy, A Johnson & Johnson Company: Paid consultant; Research support

Otero, Miguel: Submitted on: 05/27/2021
Regeneron Pharmaceuticals, Inc.: Paid consultant
Tissue Genesis Inc: Research support

Ozery, Matan: (This individual reported nothing to disclose); Submitted on: 04/02/2021

P

Palacio, Federico: (This individual reported nothing to disclose); Submitted on: 05/03/2021

Pannellini, Tania: (This individual reported nothing to disclose); Submitted on: 05/27/2021

Pannu, Tejbir: Submitted on: 06/02/2021
Journal of Orthopaedic Surgery and Research: Editorial or governing board

Parks, Michael: Submitted on: 06/01/2021
Orthopaedic Research and Education Foundation: Board or committee member
Orthopedic Learning Center (OLC): Board or committee member
Zimmer: Paid consultant

Parvizi, Javad: Submitted on: 04/14/2021
Acumed, LLC: Stock or stock Options
Alphaeon: Stock or stock Options
Becton Dickenson: Publishing royalties, financial or material support
Ceribell: Stock or stock Options
Corentec: IP royalties; Paid consultant; Stock or stock options

Patel, Robin: Submitted on: 10/07/2020
American Society of Microbiology: Board or committee member
ContraFect: Research support
Infectious Diseases Board Review (Faculty): Board or committee member
Mayo Clinic, Rochester MN (my employer): Employee
Merck: Research

Pensler, Elizabeth: Submitted on: 05/31/2021
AZ Solutions: Stock or stock Options

Perry, Kevin: (This individual reported nothing to disclose); Submitted on: 04/02/2021

Piuzzi, Nicolas: Submitted on: 04/16/2021
American Association of Hip and Knee Surgeons: Board or committee member
ISCT: Board or committee member
Journal of Hip Surgery: Editorial or governing board
Journal of Knee Surgery: Editorial or governing board
Orthopaedic Research Societ: Board of Committee member
Regeneron: Paid Consultant
RegenLab: Research Support
Stryker: Paid Consultant
Zimmer: Research Support

Plate, Johannes: Submitted on: 10/25/2020
Biocomposites Inc.: Research support
Total Joint Orthopedics: Paid consultant
VisualDX: Publishing royalties, financial or material support

Powers-Fletcher, Margaret:(This individual reported nothing to disclose); Submitted on: 07/21/2021

Prasidthrathsint, Kunatum: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Priddy, Lauren: Submitted on: 06/08/2021
Eli Lilly: Stock or stock Options

Johnson & Johnson: Stock or stock Options
Medtronic: Research support
OMEGA: Stock or stock Options
Procter & Gamble: Stock or stock Options

Q

Quade, Jonathan: Submitted on: 02/06/2021
Smith & Nephew: Paid consultant

R

Rabinowitz, Justin: (This individual reported nothing to disclose); Submitted on: 05/31/2021

Ralston, Micha: (This individual reported nothing to disclose); Submitted on: 07/18/2021

Rosas, Samuel:(This individual reported nothing to disclose); Submitted on: 07/26/2021

Reif, Taylor: (This individual reported nothing to disclose); Submitted on: 04/12/2021

Reznicek, Julie Elizabeth: (This individual reported nothing to disclose); Submitted on: 07/12/2021

Riaz, Talha: (This individual reported nothing to disclose); Submitted on: 06/14/2021

Riesgo, Aldo: Submitted on: 05/11/2021
Stryker: Paid consultant
Zimmer: Paid consultant

Rinehart, Kent: (This individual reported nothing to disclose); Submitted on: 06/09/2021

Rivera-O'Connor, Christina: (This individual reported nothing to disclose); Submitted on: 07/09/2021

Robin, Joseph: (This individual reported nothing to disclose); Submitted on: 05/31/2021

Rodriguez, Edward: Submitted on: 04/23/2021
Argenos: Stock or stock Options
BMC Musculoskeletal Disorders: Editorial or governing board
Globus Medical: Paid consultant
Ortholevo: Stock or stock Options
Riverside Partners: Paid consultant

Romanelli, Filippo: (This individual reported nothing to disclose); Submitted on: 06/05/2021

Rothfusz, Christopher: (This individual reported nothing to disclose); Submitted on: 06/09/2021

Rowe, Taylor: (This individual reported nothing to disclose); Submitted on: 06/02/2021

Rowe, Katherine: (This individual reported nothing to disclose); Submitted on: 06/04/2021

Rozbruch, S: Submitted on: 04/12/2021
Informa: Publishing royalties, financial or material support
Limb Lengthening Reconstruction Society: Board or committee member
Nuvasive: Paid consultant; Paid presenter or speaker
Orthospin: Paid consultant; Stock or stock Op

Rozell, Joshua: (This individual reported nothing to disclose); Submitted on: 03/29/2021

S

Sabbagh, Ramsey: (This individual reported nothing to disclose); Submitted on: 04/01/2021

Sagi, Henry: Submitted on: 11/19/2020
Acumed, LLC: IP royalties; Paid consultant
Altior GLW: Stock or stock Options
Connexions: Stock or stock Options
Journal of Orthopaedic Trauma: Editorial or governing board
Orthopaedic Trauma Association: Board or committee member

Samia, Anna Cristina: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Santana, Daniel: (This individual reported nothing to disclose); Submitted on: 05/28/2021

Sapountzis, Nicolas: (This individual reported nothing to disclose); Submitted on: 05/28/2021

Sayan, Ardalan: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Scarola, Greg: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Schmidt, Kenneth: (This individual reported nothing to disclose); Submitted on: 07/19/2021

Schmitt, Steven: Submitted on: 07/21/2021
Infectious Diseases Society of America: Board or committee member
Musculoskeletal Infection Society: Board or committee member
Up to Date: Publishing royalties, financial or material support

Schwarz, Edward: Submitted on: 10/07/2020
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

Schwarzkopf, Ran: Submitted on: 04/15/2021
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

Intelijoint: Paid consultant;

Schweizer, Marin: (This individual reported nothing to disclose); Submitted on: 06/04/2021

Sculco, Peter: Submitted on: 05/28/2021
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; Stock or stock Options

Sculco, Thomas: Submitted on: 05/29/2021
American Journal of Orthopedics: Editorial or governing board
Exactech, Inc: IP royalties
J. Robert Gladden Society: Board or committee member
Lima Orthopedic: Unpaid consultant
Orthopaedic Research and Education Foundation

Seidelman, Jessica: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Sekar, Poorani: (This individual reported nothing to disclose); Submitted on: 06/02/2021

Selemon, Nicolas: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Seyler, Thorsten: Submitted on: 07/20/2021
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
Musculoskeletal Infection Society: Board or committee member
Next Science: Research supportPattern Health: IP royalties Restor3d: IP royalties
Smith & Nephew: Paid consultant
Total Joint Orthopedics, Inc: IP royalties
Total Joint Orthopedics, Inc.: Paid consultant
Zimmer: Research support

Shah, Nihar: (This individual reported nothing to disclose); Submitted on: 02/03/2021

Sharma, Varun: (This individual reported nothing to disclose); Submitted on: 06/04/2021

Sherman, Matthew: (This individual reported nothing to disclose); Submitted on: 05/30/2021

Shohat, Noam: (This individual reported nothing to disclose); Submitted on: 10/29/2020

Sicat, Chelsea Sue: (This individual reported nothing to disclose); Submitted on: 02/10/2021

Siddiqi, Ahmed: Submitted on: 06/21/2021
AZ Solutions, LLC: Unpaid consultant

Intellijoint Surgical: Paid consultant
ROM Tech: Stock or stock Options
Zimmer: Paid consultant

Simcox, Trevor: (This individual reported nothing to disclose); Submitted on: 02/02/2021

Simpson, Stefanie: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Singh, Vivek: (This individual reported nothing to disclose); Submitted on: 05/31/2021

Sirch, Francis: (This individual reported nothing to disclose); Submitted on: 02/17/2021

Slater, Julia: (This individual reported nothing to disclose); Submitted on: 07/21/2021

Small, Ilan: (This individual reported nothing to disclose); Submitted on: 06/07/2021

Smith, Kira: (This individual reported nothing to disclose); Submitted on: 10/22/2020

Smith, Nathan: (This individual reported nothing to disclose); Submitted on: 06/07/2021

Sokhi, Upneet: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Sosa, Branden: (This individual reported nothing to disclose); Submitted on: 06/02/2021
Spitler, Clay: Submitted on: 04/01/2021
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

Springer, Bryan: Submitted on: 06/01/2021
AJRR: Board or committee member
American Association of Hip and Knee Surgeons: Board or committee member
Arthroplasty Today: Editorial or governing board
Convatec: Paid consultant
ICJR: Board or committee member
Joint purification

Spitler, Clay A: Submitted on: 04/01/2021
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
Stryker: Research support

Srinivasaraghavan, Aniruth: (This individual reported nothing to disclose); Submitted on: 06/08/2021

Staats, Amelia: (This individual reported nothing to disclose); Submitted on: 06/02/2021

Stavrakis, Alexandra: Submitted on: 06/01/2021
American Association of Hip and Knee Surgeons: Board or committee member

Stiehl, James: Submitted on: 06/01/2021
Advanced Skin and Wound Care: Editorial or governing board
Esential Robotics: Stock or stock Options
Explorer Surgical: Stock or stock Options
Innomed: IP royalties
International Academy Of Independent Medical Examiners: Board or committee member

Stockwell, Erin: (This individual reported nothing to disclose); Submitted on: 01/31/2021

Stoodley, Paul: Submitted on: 10/07/2020
Azko-Nobel: Research support
Biocomposites: Paid consultant; Research support
Biocomposites Ltd: Paid presenter or speaker
Colgate-Palmolive: Research support
Journal of Orthopaedic Research: Editorial or governing board

Streubel, Philipp Nicolas: Submitted on: 05/20/2021
Acumed, LLC: Paid presenter or speaker
Zimmer: Paid presenter or speaker

Summers, Hobie: Submitted on: 02/07/2021
AONA Trauma Education Committee: Board or committee member

T

Taha, Mariam: (This individual reported nothing to disclose); Submitted on: 06/04/2021

Tai, Don Bambino Geno: (This individual reported nothing to disclose); Submitted on: 06/02/2021

Tamton, Zoe: Submitted on: 06/01/2021
Onkos Surgical: Employee

Tande, Aaron: Submitted on: 06/03/2021
Musculoskeletal Infection Society: Board or committee member
Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Tarity, T: Submitted on: 05/25/2021
MicroGenDX: Paid consultant

Taylor, Jeremiah: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Teo, Greg: (This individual reported nothing to disclose); Submitted on: 07/15/2020

Thomas, Terence: (This individual reported nothing to disclose); Submitted on: 02/02/2021

Tiee, Madeline: (This individual reported nothing to disclose); Submitted on: 04/17/2021

Tsai, Yu Hsin: (This individual reported nothing to disclose); Submitted on: 06/03/2021

Tucker, Luke: (This individual reported nothing to disclose); Submitted on: 06/07/2021

Turkmani, Amr: (This individual reported nothing to disclose); Submitted on: 06/01/2021

U

Urish, Kenneth: Submitted on: 01/06/2021
AAOS: Board or committee member
ASTM: Board or committee member
Peptilogics: Paid consultant
Smith & Nephew: Paid consultant; Research support

V

Valenzuela, Michael: (This individual reported nothing to disclose); Submitted on: 05/28/2021

Van Nest, Duncan: (This individual reported nothing to disclose); Submitted on: 06/10/2021

Van Roy, Zachary Allen: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Varady, Nathan: (This individual reported nothing to disclose); Submitted on: 06/04/2021

Vedanaparti, Yajnesh: (This individual reported nothing to disclose); Submitted on: 04/14/2021

Villa, Jesus: (This individual reported nothing to disclose); Submitted on: 04/16/2021

Virk, Abinash: (This individual reported nothing to disclose); Submitted on: 07/13/2021

Visperas, Anabelle: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Von Keudell, Arvind: (This individual reported nothing to disclose); Submitted on: 10/19/2020

W

Wang, Jasmine: (This individual reported nothing to disclose); Submitted on: 10/01/2020

Weaver, Michael: Submitted on: 06/07/2021

Osteocentric: IP royalties

Weinert-Stein, Kaitlyn(This individual reported nothing to disclose); Submitted on: 07/21/2021

Wells, Carlos: (This individual reported nothing to disclose); Submitted on: 06/07/2021

Wengenack, Nancy: (This individual reported nothing to disclose); Submitted on: 06/02/2021

X

Xia, Yunwei: (This individual reported nothing to disclose); Submitted on: 06/02/2021

Xiang, William: (This individual reported nothing to disclose); Submitted on: 05/31/2021

Y

Yacovelli, Steven: (This individual reported nothing to disclose); Submitted on: 10/07/2020

Yang, Xu: (This individual reported nothing to disclose); Submitted on: 06/01/2021

Yoon, Richard: Submitted on: 06/03/2021
Arthrex, Inc: Paid consultant
Bicomposites: Research support
Biomet: Research support
BuiltLean: Unpaid consultant
Coventus: Research support
DePuy, A Johnson & Johnson Company: Paid consultant

Z

Zmistowski, Benjamin: (This individual reported nothing to disclose); Submitted on: 05/26/2021