FINAL
SCIENTIFIC PROGRAM

Saturday—March 16, 2019
Venetian / Sands Expo
Room 2201
Las Vegas, Nevada
General Program Information

The Mission of The Knee Society

The **Mission** of The Knee Society is to promote outstanding care to patients with knee disorders through innovative research and education.

Meeting Objectives

The objectives of the Specialty Day (Open) scientific program of The Knee Society and AAHKS are to update clinical skills and basic knowledge through research findings, to discuss the various surgical and non-surgical treatments and management of conditions related to the knee joint, to determine indications and complications in total knee arthroplasty, to critique presentations of surgical techniques and demonstrations of treatment options, and to evaluate the efficacy of new treatment options through evidence-based data.

CME Accreditation

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 Knee 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 live activity for a maximum of **7.5 AMA PRA Category 1 Credits™**. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Evaluation

Your opinion matters! Please complete your evaluation online at: [https://www.surveymonkey.com/r/KSSD2019](https://www.surveymonkey.com/r/KSSD2019) or use the QR code to access with your handheld smart device:

![QR Code](https://example.com/qr_code)

Photography

Please refrain from unauthorized photography and video recording of presentations. Your registration for, and attendance of, this session gives The Knee Society permission to capture images of session attendees and to use these images for internal and marketing purposes.
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Please join Zimmer Biomet for a non-CME Symposia
11:55 am – 1:00 pm
Lunch is provided to all participants by The Knee Society / AAHKS

Save the Date and Join Us in Orlando!

The AAOS 2020 Annual Meeting and Specialty Day

March 24-28, 2020
### Acknowledgements

#### Past Presidents of The Knee Society

<table>
<thead>
<tr>
<th>Year</th>
<th>President</th>
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<tr>
<td>1983</td>
<td>Chitranjan S. Ranawat, MD</td>
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<td>1984</td>
<td>Chitranjan S. Ranawat, MD</td>
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<tr>
<td>1985</td>
<td>Richard S. Bryan, MD  (Deceased)</td>
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<tr>
<td>1986</td>
<td>John N. Insall, MD (Deceased)</td>
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<td>1987</td>
<td>Charles O. Townley, MD (Deceased)</td>
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<td>1988</td>
<td>David G. Murray, MD</td>
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<td>1989</td>
<td>Frederick C. Ewald, MD</td>
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<td>1990</td>
<td>Lawrence D. Dorr, MD</td>
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<td>1991</td>
<td>Herbert Kaufer, MD</td>
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<td>1992</td>
<td>Paul A. Lotke, MD</td>
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<td>1993</td>
<td>Leonard Marmor, MD (Deceased)</td>
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<td>1994</td>
<td>David S. Hungerford, MD</td>
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<td>1995</td>
<td>Richard D. Scott, MD</td>
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<td>1996</td>
<td>Victor M. Goldberg, MD (Deceased)</td>
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<td>1997</td>
<td>W. Norman Scott, MD</td>
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<td>1998</td>
<td>James A. Rand, MD</td>
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<td>1999</td>
<td>Kenneth A. Krackow, MD</td>
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<td>2000</td>
<td>Thomas S. Thornhill, MD</td>
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<td>2001</td>
<td>Clifford W. Colwell, Jr., MD</td>
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<td>2002</td>
<td>Robert E. Booth, Jr., MD</td>
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<td>2003</td>
<td>Cecil H. Rorabeck, MD</td>
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<td>2004</td>
<td>Merrill A. Ritter, MD</td>
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<td>2005</td>
<td>Russell E. Windsor, MD</td>
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<td>2006</td>
<td>Gerard A. Engh, MD</td>
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<td>2007</td>
<td>Michael A. Kelly, MD</td>
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<td>2008</td>
<td>Douglas A. Dennis, MD</td>
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<td>William L. Healy, MD</td>
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<td>Arlen D. Hanssen, MD</td>
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<td>2011</td>
<td>Robert B. Bourne, MD, FRCSC</td>
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<td>2012</td>
<td>Giles R. Scuderi, MD</td>
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<td>2013</td>
<td>Steven J. MacDonald, MD, FRCSC</td>
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<td>Thomas K. Fehring, MD</td>
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<td>Thomas P. Vail, MD</td>
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<td>Thomas P. Sculco, MD</td>
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<td>Adolph V. Lombardi, Jr., MD</td>
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<tr>
<td>1991</td>
<td>J. Phillip Nelson, MD (Deceased)</td>
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<td>Chitranjan S. Ranawat, MD</td>
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<td>Richard C. Johnston, MD, MS</td>
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<td>Hugh S. Tullos, MD (Deceased)</td>
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<td>Merrill A. Ritter, MD</td>
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<td>Richard H. Rothman, MD, PhD</td>
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<td>Richard B. Welch, MD</td>
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<td>John J. Callaghan, MD</td>
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<td>Richard F. Santore, MD</td>
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<td>Joseph C. McCarthy, MD</td>
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<td>William J. Hozack, MD</td>
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<td>Daniel J. Berry, MD</td>
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<td>David G. Lewallen, MD</td>
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<td>William J. Robb, III, MD</td>
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<td>Mary I. O’Connor, MD</td>
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<td>Carlos J. Lavernia, MD</td>
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<td>Thomas P. Vail, MD</td>
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<td>Thomas K. Fehring, MD</td>
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<td>2014</td>
<td>Brian S. Parsley, MD</td>
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<td>Jay R. Lieberman, MD</td>
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<td>2016</td>
<td>William A. Jiranek, MD, FACS</td>
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<td>2017</td>
<td>Mark I. Froimson, MD, MBA</td>
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Acknowledgements

The Knee Society Executive Board

Robert L. Barrack, MD – President
Mark W. Pagnano, MD – 1st Vice President
John J. Callaghan, MD – 2nd Vice President
Robert T. Trousdale, MD – 3rd Vice President
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R. Michael Meneghini, MD – Chair-Elec, Memb. Cmte.
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Bryan D. Springer, MD – Chair-Elect, Education Cmte
R. Michael Meneghini, MD – Chair, Research Cmte
Charles L. Nelson – Member-At-Large
Henry D. Clarke, MD – Member-At-Large
Michael P. Bolognesi, MD – Chair, Technology Cmte

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Michael P. Bolognesi, MD – 1st Vice President
C. Lowry Barnes, MD – 2nd Vice President
Richard Iorio, MD – 3rd Vice President
Mark I. Froimson, MD – Immediate Past President
Gregory G. Polkowski, II, MD, MSc – Secretary
Ryan M. Nunley, MD – Treasurer
James A. Browne – Member-at-Large
J. Bohannon Mason, MD – Member-at-Large
R. Michael Meneghini, MD – Member-at-Large
Mark J. Spangehl, MD – Member-at-Large

The Knee Society Education Committee

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Bryan D. Springer, MD – Chair-Elect
Keith R. Berend, MD
Craig J. Della Valle, MD
Nicholas J. Giori, MD
Rafael J. Sierra, MD
Timothy M. Wright, PhD

AAHKS Education and Communication Council

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James A. Browne, MD – 2019 Program Chair
Matthew P. Abdel, MD – 2018 Program Chair
Stefano A. Bini, MD – Digital Health & Social Media
Samuel S. Wellman, MD – Publications
Brett R. Levine, MD – Patient & Public Relations
Joseph T. Moskal, MD -- Education

AAHKS Program Committee

Joseph T. Moskal, MD, FACS -- Chair
Brian M. Curtin, MD – Member
Jeremy M. Gililland, MD – Member
James A. Keeney, MD – Member
Kevin D. Plancher, MD – Member
Jeffrey B. Stambough, MD – Member
Joint Arthroplasty Mountain Meeting (JAMM)

presented by The Hip Society, The Knee Society, and the American Academy of Orthopaedic Surgeons

February 2 - 5, 2020 • Park City, UT

Fred D. Cushner, MD
Course Director

Aaron A. Hofmann, MD
Course Director

Adolph V. Lombardi Jr, MD, FACS
Course Director

Christopher L. Peters, MD
Course Director

Elevate your approaches with access to expertise

Get equipped with current approaches and preferred techniques for complex primary and revision total knee and total hip arthroplasty. Experts from The Hip Society and The Knee Society offer strategies to improve your operative performance and patient outcomes. This high-touch course puts you at the table with leading hip and knee surgeons in small-group roundtable discussions, plus dynamic keynotes, symposia, and lively point-counterpoint debates on treatment decision-making.

Course Highlights:

- Low participant-to-faculty ratio in roundtable format offers direct access to expertise
- Panel discussions offer strategies, tips and pearls
- "Golden Hip" and "Golden Knee" Surgical Video Competition

Register at hipsoc.org or call The Hip Society at 1-847-698-1638 or The Knee Society at 1-847-698-1632

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Fundamentals of Hip and Knee Arthroplasty for Orthopaedic Residents

April 12 – 14
Long Beach, CA
Erik N. Hansen, MD
Mark J. Spangehl, MD
Course Directors

April 26 – 28
Rosemont, IL
Brett R. Levine, MD
Michael J. Taunton, MD
Course Directors

Residents – Expand your surgical skills for hip and knee arthroplasty!
Build your surgical skills leading to proficiency at hip and knee arthroplasty in this interactive skills course designed exclusively for orthopaedic residents! Spend the majority of your time practicing bone cuts, correct ligament balancing for TKA, determining correct implant sizing and restoring biomechanics in THA, and more!

AAOS/AAHKS/KS/HS Resident Member/Resident/Post-Residency Fellow

Early Registration (received before 3/1/19) $150
Standard Registration (received on or after 3/1/19) $250

Register early and save $100!

To register, call AAOS Customer Service at 1-800-626-6726
Congratulations: The 2019 Knee Society Scientific Award Winners

Session III (9:30 am – 10:15 am)

The 2019 John N. Insall Award

Fructosamine is a Better Glycemic Marker Compared to Glycated Hemoglobin (HbA1C) in Predicting Adverse Outcomes Following Total Knee Arthroplasty: A Prospective Multicenter Study

Presenter: Noam Shohat, MD

Co-Authors: Majd Tarabichi MD, Timothy L. Tanm MD, Karan Goswami MD, Matthew Kheir, BA, Arthur L. Malkani MD, Roshan P. Shah MD, JD, Ran Schwarzkopf MD, Javad Parvizi MD, FRCS

The 2019 Chitranjan S. Ranawat Award

Elective Joint Replacement Outcomes Improve in Malnourished Patients with Nutritional Intervention: A Prospective Population Analysis Demonstrates a Modifiable Risk Factor

Presenter: William C. Schroer, MD

Co-Authors: Angela R. LeMarr, RN, BSN, ONC; Karen Mills, JD, RDN, LD; Amber Childress, BS, RN, ONC; Diane J. Morton, MS; Mary E. Reedy, RN, ONC

The 2019 Mark Coventry Award

A Multi-center Randomized Clinical Trial of Tranexamic Acid in Revision Total Knee Arthroplasty: Does the Dosing Regimen Matter?

Presenter: Yale A. Fillingham, MD

Co-Authors: Brian Darrith, MD, Tyler E. Calkins, Matthew P. Abdel, MD, Arthur L. Malkani, MD, Ran Schwarzkopf, MD, Douglas E. Padgett, MD, Chris Culvern, MD, Robert A. Sershon, MD, Stefano Bini, MD, Craig J. Della Valle, MD and the Hip Society Research Group
The John N. Insall Traveling Fellowship

John N. Insall’s legendary contributions to knee surgery were based on an academic pursuit of excellence in clinical research and patient care. His research endeavors encompassed biomechanics, surgical techniques and vigilant post-operative clinical follow-up. Inherent in his life’s work was the importance of educating knee surgeons worldwide. In recognition of his contributions and a desire to perpetuate his legacy, The Knee Society with the support of the Insall Foundation has endorsed the Insall Traveling Fellowship.

Since 2002, a group of four international surgeons have traveled around North America for one month to various Knee Society member programs. This fellowship continues to foster education and research, with a sharing of ideas, techniques and camaraderie between the traveling fellows and The Knee Society members.

The annual deadline to apply for the Insall Fellowship is October 1. Fellowship will take place in the year following the application deadline. To download the application, go to www.kneesociety.org and look under the Education tab.

With any questions regarding the Fellowship, please contact:
Kathleen E. Lenhardt
Phone: (646) 293-7520
Email: klenhardt@iskinstitute.com

Congratulations to the 2018 Insall Traveling Fellows:

Derek Amanatullah, MD
Stanford University
Redwood City, CA

Stephen Duncan, MD
University of Kentucky
Lexington, KY

Stefano M. Rossi, MD
University Hospital of Pavia, Italy

Peter K. Sculco, MD
Hospital for Special Surgery
New York, NY
2019 AAHKS Annual Meeting
Call for Submissions

ABSTRACTS AND SYMPOSIUM PROPOSALS DUE JUNE 1, 2019

Submit high-quality scientific and socioeconomic abstracts for consideration as podium or poster presentations. Abstracts are blind reviewed by the AAHKS Program Committee review team.

Submit Symposium proposals covering all aspects of arthroplasty and health policy. Proposals are reviewed by the AAHKS Program Committee.

Start your submission now by logging in to www.AAHKS.org

Save the Date!
November 7-10, 2019
Hilton Anatole
Dallas, Texas, USA
Registration opens in May.
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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| 7:55 am – 8:00 am | **WELCOME**  
Douglas E. Padgett, MD (New York, NY) – President, The Hip Society |
| 8:00 am – 8:30 am | **DEBATE I: Surgical Approaches: Does it Matter?**  
Moderator: John J. Callaghan, MD (Iowa City, IA) |
| 8:02 am – 8:12 am | Anterior Hip Approach  
Wael K. Barsoum, MD (Weston, FL) |
| 8:13 am – 8:23 am | Posterior Hip Approach  
Robert T. Trousdale, MD (Rochester, MN) |
| 8:23 am – 8:30 am | **DISCUSSION** |
| 8:30 am – 9:10 am | **Session I: Decreasing Complications**  
Moderator: William A. Jiranek, MD (Durham, NC) |
| 8:30 am – 8:36 am | Scope of Problem  
David C. Ayers, MD (Worcester, MA) |
| 8:37 am – 8:43 am | VTE Update  
Paul F. Lachiewicz, MD (Chapel Hill, NC) |
| 8:44 am – 8:50 am | Implant Loosening  
Michael Tanzer, MD, FRCSC (Montreal, QC, Canada) |
| 8:51 am – 8:57 am | Modifying Risk Factors  
Richard Iorio, MD (Boston, MA) |
| 8:57 am – 9:10 am | **DISCUSSION** |
| 9:10 am – 10:00 am | **Session II: Hip Instability**  
Moderator: William J. Maloney, III, MD (Redwood City, CA) |
| 9:10 am – 9:16 am | Bearing: Role for “Standard” Head Sizes  
Amar S. Ranawat, MD (New York, NY) |
| 9:17 am – 9:23 am | Soft Tissue Procedures  
Stephen J. Incavo, MD (Houston, TX) |
| 9:24 am – 9:30 am | Bearing: Dual Mobility  
Arlen D. Hanssen, MD (Rochester, MN) |
| 9:31 am – 9:37 am | Bearing: Constrained Options  
Thomas P. Sculco, MD (New York, NY) |
| 9:38 am – 9:44 am | Acetabular Positioning  
Robert L. Barrack, MD (St. Louis, MO) |
<p>| 9:44 am – 10:00 am | <strong>DISCUSSION</strong> |
| 10:00 am – 10:15 am | <strong>COFFEE / REFRESHMENT BREAK</strong> |</p>
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<tr>
<td>7:55 am – 8:00 am</td>
<td>WELCOME</td>
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<td>Robert L. Barrack, MD (St. Louis, MO), – President, The Knee Society</td>
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<tr>
<td>8:00 am – 9:10 am</td>
<td>Session I: Non-Operative Management of the Painful Knee: Biologics and Other Options. What Should You Be Doing?</td>
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<td>Moderator: Jay R. Lieberman, MD (Los Angeles, CA)</td>
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<td>8:00 am – 8:05 am</td>
<td>Introduction</td>
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<td>Jay R. Lieberman, MD (Los Angeles, CA)</td>
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<td>8:06 am – 8:11 am</td>
<td>The Regulatory Environment: How Does It Influence Your Treatment Options?</td>
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<td>Thomas P. Vail, MD (San Francisco, CA)</td>
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<td>8:12 am – 8:17 am</td>
<td>Oral Agents: It's A Good Start!</td>
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<td>Henry D. Clarke, MD (Phoenix, AZ)</td>
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<td>8:18 am – 8:23 am</td>
<td>Corticosteroid Injections: Do They Really Work?</td>
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<td>David F. Dalury, MD (Towson, MD)</td>
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<td>8:24 am – 8:29 am</td>
<td>Hyaluronic Acid: What's the Fuss?</td>
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<td>William J. Maloney, III, MD (Redwood City, CA)</td>
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<td>8:30 am – 8:35 am</td>
<td>Platelet-Rich Plasma: What, Where, and When?</td>
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<td>Scott A. Rodeo, MD (New York, NY)</td>
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<td>8:36 am – 8:41 am</td>
<td>Stem Cells: Hype or Reality?</td>
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<td>Jason L. Dragoo, MD (Redwood City, CA)</td>
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<td>8:41 am – 9:10 am</td>
<td>DISCUSSION</td>
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<td>9:10 am – 10:00 am</td>
<td>Session II: Special Highlights</td>
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<td>Moderator: Thomas P. Vail, MD (San Francisco, CA)</td>
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<td>Noam Shohat, MD (Tel Aviv, Israel)</td>
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<td>The Chitranjan S. Ranawat Award</td>
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<td>A Multi-center Randomized Clinical Trial of Tranexamic Acid in Revision Total Knee Arthroplasty: Does the Dosing Regimen Matter?</td>
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<td>Yale A. Fillingham, MD (Hanover, NH)</td>
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<td>9:43 am – 9:48 am</td>
<td>The Insall Travelling Fellowship Update</td>
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<td>W. Norman Scott, MD, FACS (New York, NY)</td>
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<td>10:15 am</td>
<td><strong>Session III: Special Highlights</strong></td>
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<td><em>Awards Moderator: Mathias P.G. Bostrom, MD (New York, NY)</em></td>
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<td>10:15 am</td>
<td>The John Charnley Award</td>
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<td>Increased PJI Risk Following Primary TKA and THA with Alternatives to Cefazolin: The Value of Allergy Testing for Antibiotic Prophylaxis</td>
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<td>10:15 am</td>
<td>Cody C. Wyles, MD (Rochester, MN)</td>
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<td>10:25 am</td>
<td>The Otto Aufranc Award</td>
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<td>10:25 am</td>
<td>Cluster-Randomized Trial of Opiate-Sparing Analgesia after Discharge from Elective Hip Surgery</td>
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<td>10:25 am</td>
<td>Majd Tarabichi, MD (Chicago, IL)</td>
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<td>10:35 am</td>
<td>The Frank Stinchfield Award</td>
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<td>10:35 am</td>
<td>An Approach Based Comparison of Periprosthetic Joint Infection Rates in Total Hip Arthroplasty: A Single Institution Experience</td>
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<td>10:35 am</td>
<td>Vinay K. Aggarwal, MD (Palo Alto, CA)</td>
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<td>10:45 am</td>
<td>The Hip Society Lifetime Achievement Award</td>
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<td>10:45 am</td>
<td>Presented by Douglas E. Padgett, MD</td>
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<td>10:50 am</td>
<td>Recap of the 2018 Rothman-Ranawat Fellowship</td>
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<td>The Hip Society's Rothman-Ranawat Traveling Fellowship</td>
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<td>Benjamin M. Stronach, MD (Jackson, MS) &amp; Elie S. Ghanem, MD (Birmingham, AL)</td>
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<td>10:55 am</td>
<td>Tribute to Richard H. Rothman, MD, PhD</td>
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<td>10:55 am</td>
<td>Douglas E. Padgett, MD (New York, NY)</td>
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<td>11:00 am</td>
<td>Introduction of the 2019 Rothman-Ranawat Fellows</td>
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<td>11:00 am</td>
<td>Adolph V. Lombardi, Jr., MD (New Albany, OH)</td>
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<tr>
<td>11:00 am</td>
<td>Presidential Guest Speaker</td>
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<td>11:00 am</td>
<td>Jeremy L. Gilbert, Ph.D., FBSE</td>
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<tr>
<td>11:00 am</td>
<td>Professor of Bioengineering</td>
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<td>11:00 am</td>
<td>Clemson University</td>
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<tr>
<td>11:00 am</td>
<td>Professor of Orthopaedics</td>
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<tr>
<td>11:00 am</td>
<td>Medical University of South Carolina (Charleston, SC)</td>
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<td>Time</td>
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</table>
| 9:49 am – 9:54 am | Highlights from The Knee Society's 2018 Members Meeting  
Ryan M. Nunley, MD (St. Louis, MO) |
| 9:55 am – 10:00 am | Highlights from the ORS 2019 Annual Meeting  
Timothy M, Wright, PhD (New York, NY) |
| 10:00 am – 10:15 am | COFFEE / REFRESHMENT BREAK |
| 10:15 am – 11:15 am | Session III: Patient Selection and Optimization  
Moderator: Bryan D. Springer, MD (Charlotte, NC) |
| 10:15 am – 10:21 am | Avoiding Dissatisfaction (Osteoarthritis Study Initiative)  
William A. Jiranek, MD (Durham, NC) |
| 10:22 am – 10:28 am | Managing the Medical Co-Morbidities: Modifiable and Non-Modifiable  
Matthew S. Austin, MD (Philadelphia, PA) |
| 10:29 am – 10:35 am | Managing the Non-Medical Co-Morbidities: Depression, Mental Illness, Coping and Resilience  
James A. Browne, MD (Charlottesville, VA) |
| 10:36 am – 10:45 am | Mini-Debate I: Is Obesity a Hard Stop?  
Affirm – David F. Dalury, MD (Towson, MD)  
Oppose – Nicholas J. Giori, MD (Palo Alto, CA) |
| 10:46 am – 10:55 am | Mini-Debate II: Is Smoking a Hard Stop?  
Affirm – William B. Macaulay, MD (New York, NY)  
Oppose – Michael J. Dunbar, MD, PhD (Halifax, NS, Canada) |
| 10:56 am – 11:15 am | DISCUSSION |
## Debate II: Outpatient THRs

**Moderator:** Joshua J. Jacobs, MD (Chicago, IL)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Speaker</th>
<th>Location</th>
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<tbody>
<tr>
<td>11:17 am</td>
<td>Pros</td>
<td>Keith R. Berend, MD (New Albany, OH)</td>
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<tr>
<td>11:27 am</td>
<td>Cons</td>
<td>Michael P. Bolognesi, MD (Durham, NC)</td>
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<tr>
<td>11:39 am</td>
<td>Reality and Economics</td>
<td>Kevin J. Bozic, MD (Austin, TX)</td>
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<tr>
<td>11:45 am</td>
<td>Discussion</td>
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### Please join Zimmer Biomet for a non-CME Symposia.
Lunch is provided to all participants by The Hip Society / AAHKS

## Session IV: Lessons Learned from Difficult Cases

**Moderator:** Daniel J. Berry, MD (Rochester, MN)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Speaker</th>
<th>Location</th>
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<tbody>
<tr>
<td>1:00 pm</td>
<td>Case 1</td>
<td>C. Anderson Engh, Jr., MD (Alexandria, VA)</td>
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<tr>
<td>1:07 pm</td>
<td>Case 2</td>
<td>Ran Schwarzkopf, MD, MSc (New York, NY)</td>
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<tr>
<td>1:14 pm</td>
<td>Case 3</td>
<td>James I. Huddleston, III, MD (Redwood City, CA)</td>
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<tr>
<td>1:21 pm</td>
<td>Case 4</td>
<td>Jay R. Lieberman, MD (Los Angeles, CA)</td>
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<td>1:27 pm</td>
<td>DISCUSSION/ AUDIENCE VOTES</td>
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## Session V: Young Adult Hip

**Moderator:** Rafael J. Sierra, MD (Rochester, MN)

<table>
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<tr>
<th>Time</th>
<th>Activity</th>
<th>Speaker</th>
<th>Location</th>
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<tbody>
<tr>
<td>1:45 pm</td>
<td>Contemporary Treatment of Femoroacetabular Impingement</td>
<td>John C. Clohisy, MD (St. Louis, MO)</td>
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<tr>
<td>1:52 pm</td>
<td>Osteotomy</td>
<td>Michael B. Millis, MD (Boston, MA)</td>
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<tr>
<td>1:59 pm</td>
<td>Resurfacing</td>
<td>Paul E. Beaulé, MD, FRCSC (Ottawa, ON, Canada)</td>
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</tr>
<tr>
<td>2:06 pm</td>
<td>THA in pediatric, Adolescent and Young Adult</td>
<td>Oleg A Safir, MD, MEd, FRCSC (Toronto, ON, Canada)</td>
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<tr>
<td>2:11 pm</td>
<td>DISCUSSION</td>
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<tr>
<td>Time</td>
<td>Session IV: The Painful TKA Diagnostic Dilemmas: Case Presentations and Panel Discussion</td>
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<tr>
<td>11:15 am – 11:55 am</td>
<td>Moderator: Daniel J. Berry, MD (Rochester, MN)</td>
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</table>

Panelists:
- Christopher L. Peters, MD
- Douglas D.R. Naudie, MD, FRCSC (London, ON, Canada)
- Jean Noel Argenson, MD (Marseille, France)
- Mark W. Pagnano, MD (Rochester, MN)
- Russel E. Windsor, MD (New York, NY)

<table>
<thead>
<tr>
<th>Time</th>
<th>Algorithm for the TKA with Occult Pain</th>
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<tr>
<td>11:39 am – 11:45 am</td>
<td>Daniel J. Berry, MD (Rochester, MN)</td>
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<th>Time</th>
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<tr>
<th>Time</th>
<th>Session V: Current Debates in TKA</th>
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<tr>
<td>1:00 pm – 2:05 pm</td>
<td>Moderator: Thomas S. Thornhill, MD (Boston, MA)</td>
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<thead>
<tr>
<th>Time</th>
<th>Mini-Debate I: Robotic UKA Expensive and Unnecessary</th>
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<tbody>
<tr>
<td>1:00 pm – 1:06 pm</td>
<td>David W. Murray, MD, FRCS (Oxford, United Kingdom)</td>
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<tr>
<th>Time</th>
<th>It is the Future of UKA</th>
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<tr>
<td>1:07 pm – 1:13 pm</td>
<td>Fares S. Haddad, MD (London, United Kingdom)</td>
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<tr>
<th>Time</th>
<th>DISCUSSION</th>
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<tr>
<th>Time</th>
<th>Mini-Debate II: Antibiotic Cement in Primary TKA Routine Use Justified</th>
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<tbody>
<tr>
<td>1:22 pm – 1:28 pm</td>
<td>Henry D. Clarke, MD (Phoenix, AZ)</td>
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<tr>
<th>Time</th>
<th>It Should be used Sparingly</th>
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<td>1:29 pm – 1:35 pm</td>
<td>Arlen D. Hanssen, MD (Rochester, MN)</td>
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<th>Time</th>
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<tr>
<th>Time</th>
<th>Mini-Debate III: Metal Allergy in TKA An Occasional Cause of Symptoms and Failure</th>
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<tbody>
<tr>
<td>1:44 pm – 1:49 pm</td>
<td>Joshua J. Jacobs, MD (Chicago, IL)</td>
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<tr>
<th>Time</th>
<th>It Doesn’t Even Exist</th>
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<tbody>
<tr>
<td>1:50 pm – 1:55 pm</td>
<td>Mark W. Pagnano, MD (Rochester, MN)</td>
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<tr>
<th>Time</th>
<th>DISCUSSION</th>
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Please join Zimmer Biomet for a non-CME Symposia.
Lunch is provided to all participants by The Knee Society / AAHKS
<table>
<thead>
<tr>
<th>Time</th>
<th>Session VI- A: Revision THR: Acetabular Issues</th>
<th>Moderator</th>
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</thead>
<tbody>
<tr>
<td>2:30 pm – 2:36 pm</td>
<td>Jumbo Cups</td>
<td>Scott M. Sporer, MD (Winfield, IL)</td>
</tr>
<tr>
<td>2:37 pm – 2:42 pm</td>
<td>Wedges and Augments</td>
<td>Richard W. McCalden, MD (London, ON, Canada)</td>
</tr>
<tr>
<td>2:43 pm – 2:49 pm</td>
<td>Custom Flanged Cups</td>
<td>Douglas A. Dennis, MD (Denver, CO)</td>
</tr>
<tr>
<td>2:60 pm – 2:56 pm</td>
<td>Cup Cage</td>
<td>Allan E. Gross, MD, FRCSC, O. Ont. (Toronto, ON, Canada)</td>
</tr>
<tr>
<td>2:57 pm – 3:03 pm</td>
<td>DISCUSSION</td>
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<thead>
<tr>
<th>Time</th>
<th>Session VI-B Revision THR: Femur</th>
<th>Moderator</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:04 pm – 3:10 pm</td>
<td>Fluted Tapered Stems</td>
<td>Don S. Garbuz, MD, MHSc, FRCSC (Vancouver, BC, Canada)</td>
</tr>
<tr>
<td>3:11pm – 3:17 pm</td>
<td>Managing Bone Loss</td>
<td>Gwo-Chin Lee, MD (Philadelphia, PA)</td>
</tr>
<tr>
<td>3:18pm – 3:24pm</td>
<td>Peri-Prosthetic Fractures</td>
<td>Emil H. Schemitsch, MD (London, ON, Canada)</td>
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<tr>
<td>3:24pm – 3:40pm</td>
<td>DISCUSSION</td>
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<tr>
<th>Time</th>
<th>COFFEE / REFRESHMENT BREAK</th>
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</table>
## Session VI: Revision Techniques

**Moderator:** John J. Callaghan, MD (Iowa City, IA)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
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</table>
| 2:05 pm – 2:10 pm | Fully Cemented Stems Technique: Rationale and Results  
David G. Lewallen, MD (Rochester, MN) |
| 2:11 pm – 2:16 pm | Hybrid Fixation Technique and Results  
Keith Berend, MD (New Albany, OH) |
| 2:17 pm – 2:22 pm | Femoral and Tibial Cones Technique and Results  
R. Michael Meneghini, MD (Fishers, IN) |
| 2:23 pm – 2:28 pm | Indications and Technique for Distal Femoral Replacement  
Ryan M. Nunley, MD (St. Louis, MO) |
| 2:29 pm – 2:34 pm | One Stage Indication and Technique  
Denis Nam, MD, MSc (Chicago, IL) |
| 2:35 pm – 2:40 pm | Articulating Spacer Indications and Technique  
Michael P. Bolognesi (Durham, NC) |
| 2:41 pm – 2:46 pm | Knee Arthrodesis: Current Indications and Techniques  
Thomas K. Fehring, MD (Charlotte, NC) |
| 2:47 pm – 3:03 pm | DISCUSSION, CASE PRESENTATIONS |

## Session VII: Lessons Learned From the Legends

**Moderator:** Thomas P. Sculco, MD (New York, NY)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
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| 3:04 pm – 3:10 pm | Case 1  
Robert E. Booth, Jr., MD (Philadelphia, PA) |
| 3:11 pm – 3:17 pm | Case 2  
Adolph V. Lombardi, Jr., MD (New Albany, OH) |
| 3:18 pm – 3:24 pm | Case 3  
Kelly G. Vince, MD, FRCSC (Whangarei, New Zealand) |
| 3:25 pm – 3:31 pm | Case 4  
Michael A. Mont, MD (New York, NY) |
| 3:31 pm – 3:40 pm | DISCUSSION |
| 3:40 pm – 3:55 pm | COFFEE/REFRESHMENT BREAK |

COMBINED SESSIONS I & II  
with The Hip Society and will be held in VENETIAN/ SANDS 2201
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>3:44 pm – 4:01 pm</td>
<td>How Big is the Problem?</td>
<td>Bryan D. Springer, MD (Charlotte, NC)</td>
</tr>
<tr>
<td>4:02 pm – 4:08 pm</td>
<td>Pre-Intervention Management</td>
<td>Carlos J. Lavernia, MD (Coral Gables, FL)</td>
</tr>
<tr>
<td>4:09 pm – 4:15 pm</td>
<td>Opiate Sparing Analgesia</td>
<td>William J. Hozack, MD (Philadelphia, PA)</td>
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<tr>
<td>4:16 pm – 4:22 pm</td>
<td>Post-Operative Management</td>
<td>Craig J. Della Valle, MD (Chicago, IL)</td>
</tr>
<tr>
<td>4:23 pm – 4:40 pm</td>
<td>DISCUSSION</td>
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<tr>
<td>4:45 pm – 5:01 pm</td>
<td>Prevention</td>
<td>Michael H. Huo, MD (Dallas, TX)</td>
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<tr>
<td>5:02 pm – 5:08 pm</td>
<td>Diagnosis</td>
<td>Steven J. MacDonald, MD, FRCSC (London, ON, Canada)</td>
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<tr>
<td>5:09 pm – 5:15 pm</td>
<td>Treatment</td>
<td>R. Michael Meneghini, MD (Fishers, IN)</td>
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<tr>
<td>5:16 pm – 5:21 pm</td>
<td>Costs</td>
<td>Thomas K. Fehring, MD (Charlotte, NC)</td>
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<tr>
<td>5:21 pm – 5:35 pm</td>
<td>DISCUSSION</td>
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<tr>
<td>5:35 pm</td>
<td>MEETING ADJOURNED</td>
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The Regulatory Environment: How Does It Influence Your Treatment Options?
Thomas P. Vail, MD

There are compelling reasons to provide patients suffering from symptoms of knee arthritis with a minimally invasive and inexpensive biologic or regenerative option. Surgical treatment of knee arthritis is expensive and invasive. In theory, biologic options for treatment such as platelet injections, hyaluronate injections, and cell-based therapies could be provided in the outpatient setting at a lower overall cost when compared to surgery. On the negative side, recent reports of patients being hospitalized for infectious complications after treatment with stem cell injections into the knee joint have drawn attention to this practice.

Separate from the evolving data on efficacy and economics of biologic treatment of knee arthritis, there are regulatory considerations that can impact treatment options and the informed consent process. According to FDA Commissioner Scott Gottlieb, M.D., the recently reported adverse outcome associated with one particular stem cell product was related to “…significant deviations from CGTP and CGMP requirements in the manufacture of the umbilical cord blood-derived products, including: deficient donor eligibility practices; unvalidated manufacturing processes; uncontrolled environment; lack of control over the components used in production and a lack of defined areas or a control system to prevent contamination and mix-ups…” This finding raises concerns that all available biologic products may not be in compliance with regulatory requirements.

In the eyes of the FDA, lawful stem cell therapies are either FDA approved, or being studied under an Investigational New Drug Application (IND), which is a clinical investigation plan submitted and allowed to proceed by the FDA. The only stem cell-based products that are FDA-approved for use in the United States consist of blood-forming stem cells (hematopoietic progenitor cells) derived from cord blood. When stem cell products are used in unapproved ways—or when they are processed in ways that are more than minimally manipulated, which relates to the nature and degree of processing—the FDA may take (and has already taken) a variety of administrative and judicial actions, including criminal enforcement, depending on the violations involved. A list of approved cellular and gene therapy products is available from the FDA.

1 Regulatory considerations for human cells, tissues, and cellular and tissue based products: minimal manipulation and homologous use. US Department of Health and Human Services, FDA, Center for Biologics evaluation and research, Center for Devices and Radiologic Health, Office of Combination Products, December 2017.
1 https://www.fda.gov/ForConsumers/ConsumerUpdates/ucm286155.htm
1 https://www.fda.gov/biologicsbloodvaccines/cellulargenterapyproducts/approvedproducts/default.htm
Potential treatment options for osteoarthritis of the knee are extensive and include a variety of oral agents. In the United States, these can broadly be broken down into 4 categories: 1) non-pharmaceutical, dietary supplements 2) acetaminophen; 3) non-steroidal anti-inflammatory drugs (NSAIDS); and, 4) tramadol and opioid analgesics. Extensive literature of variable quality has been published on these subjects. In order to try to provide coherent recommendations based on the mass of data several organizations have reviewed and summarized this information in clinical guidelines and evidence-based reports. Recommendations from three prominent groups are presented: The American Academy of Orthopedic Surgeons (AAOS); The American College of Rheumatology (ACR); and Agency for Healthcare Research and Quality (AHRQ).

Non-pharmaceutical dietary supplements: AAOS guidelines: Recommendation #6: Cannot recommend using glucosamine and chondroitin. Strength of recommendation is STRONG. 21 prospective studies were evaluated. 11 of 52 outcomes were statistically significant in favor of glucosamine versus placebo, None of the critical outcomes (WOMAC pain and function, VAS pain) were different. The evidence for nutraceuticals was variable and could not be easily summarized. In concordance, ACR guidelines also conditionally recommend that patients with OA should not use Glucosamine or Chondroitin. The AHRQ evidence-based report notes that seven RCTs demonstrated no difference in pain and function versus an oral NSAID. One systematic review demonstrated no clinically significant benefit versus placebo

Acetaminophen: AAOS guidelines: Recommendation #7B: Unable to recommend for or against the use of acetaminophen. Strength of recommendation is IINCONCLUSIVE. Only 1 study of acetaminophen versus placebo was identified. No statistically significant improvement versus placebo was noted. In distinction, ACR guidelines conditionally recommend that patients with OA should use one of the following: acetaminophen, oral or topical NSAIDs. The AHRQ report concludes acetaminophen was modestly inferior to NSAIDs for pain and function in 4 systematic reviews but has fewer GI side effects.

NSAIDs: AAOS guidelines: Recommendation #7A: Recommend NSAIDs. Strength of recommendation is STRONG. 19 studies of selective or non-selective NSAIDs and 6 with topical NSAIDs were reviewed. 202 favorable outcomes were identified; 171 were statistically significant for the NSAID and 63 were possibly clinically significant. In concordance, ACR guidelines also conditionally recommend that patients with OA should use one of the following: acetaminophen, oral or topical NSAIDs. For patients over 75 years old, ACR strongly recommends topical versus oral NSAIDs. ACR also notes that if the patient has a history of upper GI ulcer but no bleed in the past year then either a COX-2 selective or non-selective NSAID in combination with a proton-pump inhibitor may be used. If patient has had a GI bleed in the past year and the practitioner still chooses to use oral NSAIDs a COX-2 selective with a proton-pump inhibitor are recommended. ACR guidelines also note that oral NSAIDs should also not be used in patients with Class IV or V CKD. The AHRQ report predicts one-year risk of GI bleed in 45-75 age range at ~1 in 600 patients and fatal bleed at ~ 1 in 3500 patients. Over 75 years old risk of bleed is ~ 1 in 100 and risk of death ~ 1 in 600. For cardiovascular risk, naproxen appeared moderately superior to COX-2 selective NSAIDs in 2 RCTs. Otherwise CV risks appear similar for COX-2 selective and non-selective NSAIDs.

Tramadol and opioids: AAOS guidelines: Recommendation #7A: Recommend NSAIDs. Strength of recommendation is STRONG. However, AAOS guidelines: Recommendation #7B: Unable to recommend for or against the use of opioids. ACR also conditionally recommends tramadol for patients with OA as an initial treatment and strongly recommends the use of opioid analgesics according to the recommendations of the American Pain Society/American Academy of Pain Medicine for patients who have not had adequate response to first line pharmaceuticals and are unable, or unwilling, to undergo joint replacement. Whether these guidelines will be modified based on public health concerns about the risks of long term opioid use and the ongoing opioid crisis is unclear.

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References:


DOI: https://doi.org/10.23970/AHRQEPCER190.

Corticosteroid Injections: Do They Really Work?

David F. Dalury, MD

Arthritis of the knee affects approximately 46 million American adults (22% of the population) and injections to treat the pain and functional deterioration caused by arthritis have been used routinely. Intra-articular cortisone into the knee was first reported by Hollander in 1951 and since then it has frequently been used for treatment of arthritis of the knee. Up to 30% of patients who have had a TKR have had an IACI. Surprisingly little data supports this common treatment.

The inflammatory process is not fully understood but the presumed mechanism of action of cortisone is that it suppresses the effect of metalloproteoglycan enzymes (cytokines such as Interleukin II-6 and TNF alpha) and this decreases the inflammatory pathways in synovial tissues.

Numerous studies have been performed over the years evaluating the safety and the efficacy IACI. Unfortunately the quality of these studies is poor with very few Level 1 studies for guidance. Cheng, et al in a review in Pain Medicine in 2012, performed a systematic review of records and 817 clinical trials of IACI to the knee and concluded that there is solid evidence to support the use of IACI into the knee for both rheumatoid arthritis patients as well as osteoarthritic patients. They found support for IACI injections providing pain relief and functional improvement for months and up to one year.

A Cochrane Review published in 2015, on the other hand, reviewed 27 trials and 1800 patients and graded the quality of the evidence as ‘low’ and found IACI to the knee to be more beneficial for pain relief than functional improvement but found the benefits to be moderate at 1-2 weeks; small to moderate at 4-6 weeks and small at 13 weeks.

There are few studies comparing which cortisone, dosage size and frequency of injection. In general it appears that Triamcinolone hexacetonide might be superior to others based on the assumption that it is less soluble. Most studies were in series where the frequency of injection was 3 months however there is no good data to support this frequency. Additionally, there is no good data to suggest a lifetime number of IACI.

The risks of a TJR following IACI has been reviewed. The data suggest that a delay of 90 days following the most recent injection is prudent.

Concerns about chondrotoxicity following IACI exist but, again, the data is inconclusive. Concern does exist about the combination of local anesthetics (know chondrotoxic risks) combined with cortisone and the recommendation is to use short acting and low dose local anesthetics for these injections.

Reports of local and systemic side effects following IACI have been published but these are generally rare and of short duration.

In summary, remarkably little data exists to support the safety and efficacy of this common procedure. Most of the literature does show a short term benefit in terms of pain relief and functional improvement in patients with knee arthritis. Further studies are needed to clarify which drug, what frequency and what are the long term side effects of an IACI.
References
Platelet-Rich Plasma: What, Where, and When?
Scott A. Rodeo, MD

I. What:
Definition of PRP:
At the most basic level, autologous blood sample with platelet count higher than whole blood after centrifugation to remove red blood cells.

However, a more refined and detailed approach is needed - other important factors to consider:
1. Leukocyte content
2. Leukocyte differential cell types
3. Fibrin content and degree of fibrin polymerization
4. Platelet: leukocyte ratio
5. Platelet activation status
6. Numerous as-yet-undefined plasma proteins: PRP contains many anabolic (cytokines, growth factors) and catabolic factors. Catabolic factors include inflammatory mediators and matrix metalloproteases.

Numerous other plasma proteins in PRP, such as vasoactive amines, serotonin, histamines, etc. likely also affect the biologic response in different tissues.

Other autologous blood preparations that are often confused with PRP:
Autologous conditioned serum (ACS)
Autologous protein solution (APS)
Alpha 2-macroglobulin

II. Where Should We Use PRP?
1. Symptoms of knee osteoarthritis:
   There is emerging data to support a role for leukocyte reduced PRP (LR-PRP) in the treatment of symptoms due to knee OA. The likely mechanism is via production of anti-inflammatory and immuno-modulatory mediators.
   Some early / limited data suggests superiority to hyaluronic acid with regard to duration of efficacy.
   There is also some early data to support superior outcome using combined PRP plus hyaluronic acid.
   Note that PRP is “symptom-modifying” but not “structure-modifying” - regeneration of functional cartilage tissue does not occur.

2. Patellar tendonopathy
   PRP has been evaluated for treatment of tendinopathy in various anatomical locations.
   The basic underlying principle would be to “turn on the biology” in order to try to induce healing in these chronic conditions.
   Emerging data suggests superior results using leukocyte-rich PRP for treatment of tendinopathy.
   There is some limited data to support the use of PRP for treatment of patellar tendonopathy.

3. Meniscus Repair: Very few studies have evaluated the use of PRP as an augment for meniscus
III. When Should We Use PRP:
And important question is the dosing schedule: Single application versus repeat dosing? Interval between doses?
There is very little rigorous, objective data to guide this decision.
Most proposed treatment protocols are empirical.
Many have suggested a series of three injections of leukocyte-reduced PRP for treatment of symptoms of knee OA. The doses are typically given at 1-2 week intervals.
Some limited data suggests superiority of three doses over a single dose.
Further studies are required.
As practicing physicians, scientists, and regulatory experts, we have increasingly observed aggressive advertising and sales tactics being used by many health clinics marketing “stem cell treatments”. These clinics are often using birth tissues, otherwise known as amniotic fluid, umbilical cord cells and other unproven treatments. They often claim that these treatments include millions of live, functional stem cells that can be used to relieve the patient’s symptoms. Patients have been spending thousands of dollars on these therapies to treat a myriad of orthopaedic problems and other incurable diseases. However, there is very little evidence to suggest that these claims are true and very little evidence that suggest that formulations of birth tissues or fluid are reasonable to include in a treatment regimen. This represents the hype of the Biologic’s movement.

However, there is plenty of good basic science, animal data, and new emerging clinical trials to suggest that there is a potential benefit of stem cell therapy. Our current understanding is that the use of the autologous cells harvested from either the patient’s bone marrow or adipose tissue do have some therapeutic effects, which are most likely centered around the reduction of inflammation and the production of therapeutic signals to change the local cellular environment. The reality is that there is often significant clinical improvement with autologous cellular therapy, but additional clinical trials will be required to understand the full utility of this treatment regimen.

The current best practice for bone marrow cell therapy is to extract bone marrow from the anterior or posterior iliac crest with a technique that involves low aspiration volume. Bone marrow concentration machines are available from many vendors that have been shown to increase the number of mesenchymal progenitor cells. However, these machines all produce different products, some of which increase the colony forming units while others will increase platelet number and others will decrease white blood cell volume. Therefore, these different devices can be used to augment certain clinical therapeutic regimens as per the specific formulation of BMAC. Current evidence is that the use of bone marrow concentrate for the treatment of symptoms of osteoarthritis is not warranted. There is evidence to suggest that the use of BMAC for the treatment of chondral defects with the use of a patch and a mini open arthrotomy similar to an ACI technique shows reasonable treatment results. However, the problem with bone marrow concentrate is the low overall number the progenitor cells that are harvested even with concentration. The actual numbers are approximately 1 in 100,000 cells or .01%.

The second compartment for the harvest of autologous cells is adipose tissue. Adipose tissue has been shown to contain a significantly greater amount of progenitor cells, approximately 20% of the overall cell volume when the cells are concentrated down to the stromal vascular fraction. Adipose tissue requires an additional fractionation step to release the pericytes from the perivascular matrix that requires the use of either ball bearing devices or syringe emulsification. Adipose tissue can either be harvested from the infrapatellar fat pad of the knee or the abdomen, thigh, or buttocks, and there is good data to show that these are adequate sites for tissue procurement. There is emerging evidence to suggest that the injection of adipose tissue derived cells can benefit patients with osteoarthritis, with more of the evidence suggesting a decrease in symptoms and some lower level evidence suggesting some possible regeneration of articular cartilage thickness. Additional clinical trials are under way. With respect to the treatment of chondral defects with adipose derived cells there are no current studies to show efficacy, however many large randomized clinical trials are being performed currently.

It is currently not recommended to use birth tissues for orthopaedic regenerative medicine procedures. Commercial amniotic fluid and tissue has been shown to contain essentially no live progenitor cells. The amount of growth factors are considerably lower than autologous products such as PRP and are therefore currently not recommended.
When formulating a treatment plan for cartilage defects, one must also consider the health of the subchondral bone. Areas of subchondral bone disease, including edema and or cystic degeneration, will likely need treatment at the time of the cartilage resurfacing. There are many techniques that can be used to treat the subchondral bone including fresh osteochondral allografts as well as bone marrow aspirate injection after core decompression or the delivery of calcium phosphate cement. This emerging evidence suggests no clear benefit of one technique versus the other, however the use of an osteochondral allograft certainly has the most evidence in its favor.

In summary, there is considerable hype for the use of stem cells but also a substantial reality that the autologous use of cell therapy may be of benefit. Indications are emerging with the results of the clinical trials which are currently being performed. The best advice is to stay updated on this rapidly changing field yearly, as the FDA will help shape the future use of cellular therapy in our patients.
Session II: Special Highlights

9:10 – 9:20 am

The John N. Insall Award

**Fructosamine is a Better Glycemic Marker Compared to Glycated Hemoglobin (HbA1C) in Predicting Adverse Outcomes Following Total Knee Arthroplasty: A Prospective Multicenter Study**

*Noam Shohat, MD*

**Background:** The proper marker for assessing glycemic control prior to total joint arthroplasty (TJA) remains unknown. This study assessed the utility of fructosamine compared to glycated hemoglobin (HbA1c) in predicting adverse outcomes following total knee arthroplasty (TKA), and determined the threshold above which the risk increases significantly.

**Methods:** This prospective multi-institutional study examined TKA patients from four institutions. All patients (both diabetics and non-diabetics) were assessed for glycemic control using fructosamine and HbA1c levels within 30 days of surgery. Adverse outcomes were assessed at 4-6 weeks and 12 weeks and included periprosthetic joint infection (PJI), wound complication, readmission, reoperation, and death. The Youden’s index determined the cutoff for fructosamine associated with complications. Two cutoffs for HbA1c were examined: 7% and 7.5% and compared to fructosamine as a predictor for complications.

**Results:** A total of 1,135 patients were included. The Youden’s index pointed out a fructosamine level of 293 μmol/L as the optimal cutoff associated with adverse outcomes (index 0.26). Patients with high fructosamine (>293 μmol/L) were 8.4 times more likely to develop PJI compared to low fructosamine (<0.01), readmission and reoperation rates were 3.6 and 4 times higher (p’s 0.01 and <0.01). The mortality rate was significantly higher at 3.3% in high fructosamine compared to 0.1% in normal fructosamine (p<0.01). These adverse outcomes remained significant in multiple regression analysis. Unlike fructosamine, neither HbA1c levels ≥ 7% nor levels ≥ 7.5% failed to show any significant association with adverse outcome.

**Conclusion:** Fructosamine is a valid and an excellent predictor of adverse outcomes following TKA. It better reflects the glycemic control closer to surgery, has greater predictive power for adverse events, and responds quicker to treatment compared to HbA1c. These findings support the screening of all patients undergoing TKA using fructosamine and in those with a level above 293 μmol/L, the risk of surgery should be carefully weighed against its benefit.
Aims: To date no study has demonstrated an improvement in postoperative outcomes following elective joint replacement with a focus on nutritional intervention for patients with preoperative hypoalbuminemia. In this prospective study, we evaluated differences in the hospital length of stay, rate of readmission, and total patient charges for a malnourished patient study population who received a specific nutrition protocol before surgery.

Patients and Methods: An analytic EMR report of a five-hospital network extracted joint replacement patient data from 2014-2017: 4733 patients underwent joint replacement; 2,220 at four hospitals and 2,513 at the study hospital. Albumin ≤3.5g/dL, designated as malnutrition, was found in 543 patients (11.5%). A nutritional intervention program focusing on a high protein, anti-inflammatory diet was initiated in January 2017 at one study hospital. Hospital length of stay, readmission rate, and 90-day charges were compared for differential change between patients in study and control hospitals for all elective hip and knee replacement patients, and for malnourished patients over time as the nutrition intervention was implemented.

Results: Malnourished patients with nutritional intervention at the study hospital had shorter hospital length of stay beginning in 2017 than malnourished patients at control hospitals during the same period, p=0.04. Similarly, this cohort had significantly lower primary hospitalization charges, charges associated with hospital readmissions, and 90-day total charges, p<0.0001. Inclusion of covariant potential confounders (age, anemia, diabetes, and obesity) did not alter the conclusions of the primary statistical analysis.

Conclusion: Joint replacement outcomes were positively affected in study patients with low albumin when a high-protein, anti-inflammatory diet was encouraged. Elective surgery was neither cancelled nor delayed with a malnutrition designation. While the entire network population experienced improved postoperative outcomes, malnourished control patients did not experience this improvement. This study demonstrated that malnutrition can be positively modified.
The Mark Coventry Award

A Multi-center Randomized Clinical Trial of Tranexamic Acid in Revision Total Knee Arthroplasty: Does the Dosing Regimen Matter?

Yale A. Fillingham, MD

Aims: Tranexamic acid (TXA) is proven to reduce blood loss following total knee arthroplasty (TKA), but there are limited data on the impact of similar dosing regimens in revision TKA. The purpose of this multi-center randomized clinical trial was to determine the optimal regimen to maximize the blood-sparing properties of TXA in revision TKA.

Methods: From six-centers, 233 revision TKAs were randomized to one of four regimens: One-gram of intravenous (IV) TXA given prior to the skin incision, a double-dose regimen of 1g IV TXA given both prior to skin incision and at time of wound closure, a combination of 1g IV TXA given prior to skin incision and 1g of intra-operative topical TXA, or three doses of 1950mg oral TXA given 2-hours pre-operatively, 6-hours post-operatively, and on the morning of post-operative day-one. Randomization was performed based on the type of revision procedure to ensure equivalent distribution amongst groups. Power analysis determined that 40 patients per group were necessary to identify a 1g/dL difference in the reduction of hemoglobin post-operatively between groups with an alpha of 0.05 and power of 0.80. Per-protocol analysis

Results: One patient withdrew, five did not undergo surgery, 16 were screening failures, and 25 did not receive the assigned treatment, leaving 186 patients for analysis. There was no significant difference in hemoglobin reduction amongst treatments (2.8g/dL for single-dose IV TXA, 2.6g/dL for double-dose IV TXA, 2.6g/dL for combined IV/topical TXA, 2.9g/dL for oral TXA; p=0.38). Similarly, calculated blood loss (p=0.65) and transfusion rates (p=0.95) were not significantly different between groups. Equivalence testing assuming a 1g/dL difference in hemoglobin change as clinically relevant showed all possible pairings were statistically equivalent.

Conclusions: Despite the higher risk of blood loss in revision TKA, all TXA regimens tested had equivalent blood-sparing properties. Surgeons should consider using the lowest effective dose and least costly TXA regimen in revision TKA.
Avoiding Dissatisfaction (Osteoarthritis Study Initiative)
William A. Jiranek, MD

I. Causes of Dissatisfaction

1. Inadequate management of expectations
2. Insufficient improvement over preop function
3. Persistent Pain
4. Occurrence of a complication
5. Didn’t believe the treatment selected was the correct one
   (Insufficient Shared Decision Making)

II. Insufficient Psychosocial Evaluation (Preliminary data suggests >50% have psychosocial comorbidity)
1. PROMIS
2. EQ5D
3. OSPRO
4. PCS

III. Developing Appropriate use criteria
1. Radiographic Criteria
2. PRO Criteria
3. Functional Criteria

IV. Satisfaction Measures
1. Net Promoter Score (Overall Program)
2. HCHAPs (Hospital)
3. Star Rating (the surgeon)

V. References

Managing the Medical Co-Morbidities: Modifiable and Non-Modifiable
Matthew S. Austin, MD

Personal Disclosures
- Consultant
  - Zimmer Biomet
  - Link
  - Corin
- Research Support
  - Zimmer Biomet
- Royalties
  - Zimmer Biomet
  - Jaypee Publishers
- Intellectual Property/Ownership
  - CrossCurrent, LLC
  - OBEDO, LLC
  - Foer Thrompraxis
  - For MD, Inc
  - Rothman-owned facilities
  - Pulse
  - Board Member/Advisor
  - Deputy Editor, JAAOS
  - AAHKS E/RM Committee
  - AAOS Hip and Knee Content Committee

Why Should We Care About Co-morbidities?
Risk Factors

Non-modifiable
- Age
- Gender
- Race
- Socioeconomic status
- Neurocognitive disorders
- Coagulopathies
- Cirrhosis

Modifiable to some degree
- Deconditioning
- Hypertension
- Fall risk
- Cardiovascular disease
- Renal disease
- Anemia
- Metabolic syndrome

"Modifiable" Risk Factors

- Smoking
- Nutritional status
- Obesity
- Diabetes
- Narcotic dependence
- Alcohol dependence
- Toncical calzation

Prevalence of Risk Factors

40% of all hips and knees revised within 2 years have at least 1 modifiable risk factor.
Smoking

- Risks involved:

- Tests to order: Serum cotinine <100 ng/mL

Smoking

- Impact of Correction: Need more evidence

Prospective randomized study of 120 patients
Smoking cessation vs. no intervention
- 54% of cessation group stopped smoking vs. 18% of no intervention
Cessation group:
- Significant reduction in wound complications (20% vs. 30%)
- Significant reduction in need for further surgery (15% vs. 30%)
Moller Ugoz Laker 2006
How long does one need to quit?: 4-6 weeks (maybe)
Moller Ugoz Laker 2006
Vilipioq Cism Repar 2008
Lindstrom Ann Surg 2008
Diabetes

- Risks involved:

- Tests to order: HbA1c, threshold:
  - 7.7%, no association, 7-7.5%, 8%
  - Blood glucose threshold:
    - 104mg/dL
  - Threshold may need to be individualized

- CDC: Up to 1/3 of patients with DM are undiagnosed
- Random glucose testing >200mg/dL
- Cost of HbA1c: $35.00
- Shroyer JA 2013

- Target:
  - Postoperative glycemic control may be more critical than HbA1c

- Mean glucose levels >200mg/dL or spike >160mg/dL associated with wound complications
- Stryker 2013

- All patients, not just patients with DM, may benefit from glucose monitoring
- Maroulis / Haddad 5th Edition 2013

- Use of insulin sliding scale to maintain levels 140-180mg/dL
- Target may not be normoglycemia (insulin release of glucose is a stress response)
- Stryker 2013
Managing the Non-Medical Co-Morbidities: Depression, Mental Illness, Coping and Resilience
James A. Browne, MD

“What’s the difference between a knee replacement surgeon and a psychiatrist? The psychiatrist knew they were getting into psychiatry”

The association between mental health and surgical outcome is widely recognized but complex and poorly understood. A patient’s mental health status has been shown to be a significant factor in predicting outcomes following TKA. While most agree that mental health status should be assessed prior to surgery and taken into consideration during post-operative care, very few orthopaedic surgeons actually make a psychiatric assessment of their patients. Furthermore, few practical strategies have been described to help manage these conditions, and it is unclear to what extent outcomes could be improved through intervention.

Depression, anxiety, and pain catastrophizing have been identified as independent risk factors for the development of chronic pain after TKA (1), persistent opioid use (2), and an increased risk of dissatisfaction (3). An association between depression and postoperative morbidity including infection has also been reported (4). There is no consensus as to the best way to screen patients for mental health disorders and when to delay surgery for psychiatric optimization (5). The PCS (pain catastrophizing), GAD-2 (anxiety), and PHQ-2 (depression) are screening tools that may be employed in clinical practice and are included below. Heightened awareness of these mental health comorbidities preoperatively may allow for modification and optimization through medical management and cognitive behavioral therapy.

Coping and resilience are related concepts that may describe the trajectories of depression and anxiety following health-related adversities like TKA. Coping skills and resiliency are generally thought to be behaviors that can be taught, modeled, and learned. Techniques that surgeons may employ to help their patients in the short term will be discussed.

Patient Health Questionnaire-2 (PHQ-2): Screening instrument for depression

<table>
<thead>
<tr>
<th>Over the past 2 weeks, how often have you been bothered by the following problems?</th>
<th>Not at all</th>
<th>Several days</th>
<th>More than one-half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little interest or pleasure in doing things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling down, depressed or hopeless</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

PHQ-2 score is obtained by adding the score for each question. A score of 3 or greater is suggestive of depression.

Generalized Anxiety Disorder 2-item (GAD-2): Screening instrument for anxiety

<table>
<thead>
<tr>
<th>Over the past 2 weeks, how often have you been bothered by the following problems?</th>
<th>Not at all</th>
<th>Several days</th>
<th>More than one-half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeling nervous, anxious or on edge</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Not being able to stop or control worrying</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

GAD-2 score is obtained by adding the score for each question. If the score is 3 or greater, further diagnostic evaluation for generalized anxiety disorder is warranted.
Model of resilience (a) and trajectories of risk and resilience (b). From Rutten et al, Acta Psychiatrica Scandinavica. 2013 128(1), pp. 3-20

References

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Algorithm for the TKA with Occult Pain
Daniel J. Berry, MD

With the large number of TKAs performed annually, and a 10-15% incidence of less than complete patient satisfaction after TKA, evaluation for occult pain after TKA is common. Identifying treatable sources of pain is important. Likewise, because further surgery is mostly ineffective when a treatable source of pain cannot be established, it is important to know when NOT to re-operate.

An algorithmic approach can be used to evaluate pain after TKA, systematically searching for the diagnoses that lead to pain after TKA. This approach relies on understanding the differential diagnosis of pain after TKA, and how to use the history, physical examination, radiographic studies, and laboratory studies to systematically evaluate for each potential source of pain including: infection, implant loosening, polyethylene wear, instability, soft tissue impingement, implant mal-sizing/mal-position. The moderator will use a case-based approach and a panel of experts to illustrate the best way to evaluate each of common diagnoses leading to pain after TKA.

In some patients, the pain may be from a source that is not readily treatable surgically, and the panel will also discuss how most effectively to manage these cases.
The advantages of unicompartmental knee arthroplasty (UKA) over total knee arthroplasty (TKA) include reduced operating time, decreased intraoperative blood loss, reduced periarticular soft-tissue trauma, improved preservation of bone stock, better restoration of native kinematics, increased patient satisfaction, and improved functional outcomes.1-3 However, UKA is associated with reduced implant survivorship and increased revision rates compared with TKA.4-5

Accuracy of implant positioning and limb alignment are important prognostic factors for implant survivorship following UKA.6-9 Accordingly, techniques that improve component positioning may reduce the burden of revision surgery in UKA. Robotic-arm assisted UKA is associated with increased accuracy of implant position and alignment compared with conventional jig-based UKA.10-14. This may translate to improved long-term implant survival and also facilitate the implementation of cementless implants for UKA.

Cobb et al conducted a prospective randomised study on 27 patients with medial compartment osteoarthritis undergoing conventional jig-based UKA or robotic-arm assisted UKA.10 The authors reported that all patients undergoing robotic-arm assisted UKA had tibiofemoral alignment in the coronal plane within 2° of the planned position compared with only 40% in those undergoing conventional jig-based UKA.10 Bell et al performed a prospective randomised controlled study comparing 62 robotic-arm assisted UKAs with 58 conventional UKAs.11 Using postoperative CT scans to assess component positioning, the authors found that the use of robotic assistance resulted in lower root mean square errors (RMSEs) in all component parameters for both the tibial and femoral implant positioning.

Lonner et al used plan radiographs to compare accuracy of implant position in 31 robotic-arm assisted UKAs versus 27 conventional manual UKAs. Robotic UKA was associated with improved accuracy in achieving the planned coronal implant position, posterior tibial slope, and 2.6 times less variance in implant position than conventional manual UKA.14 Kayani et al performed a prospective cohort study on 60 conventional jig-based UKAs versus 60 robotic-arm assisted UKAs, and found improved accuracy of achieving the planned femoral and tibial implant position in the robotic group.13 Accuracy of implant position was assessed using plain radiographs but RMSE values were comparable to those reported using CT scans in the randomised controlled trial by Bell et al.11

Robotic arm assisted UKA uses a preoperative CT scan and computer-aided design (CAD) model to plan optimal implant position based on the patient’s unique anatomy, and then an interactive robotic arm to help execute this plan with a high-level of accuracy. Stereotactic boundaries limit surgeon-controlled errors in bone resection and iatrogenic periarticular soft tissue injury. Kayani et al assessed the learning curve of robotic-arm assisted UKA by assessing surrogate markers of the learning curve in 60 consecutive patients following the implementation of this procedure into routine arthroplasty practice. The authors reported operative times and surgical team comfort levels improved with cumulative surgical experience but there was learning curve for achieving the planned femoral or tibial implant position.13 They also found that there was no learning curve effect for achieving the planned posterior condylar offset ratio, posterior tibial slope, joint line restoration, and limb alignment. These findings are important for the safe incorporation of this technology into routine surgical practice but also for making UKA more adoptable by low-volume arthroplasty surgeons. Robotic technology may enable low-volume UKA surgeons to perform this procedure with a high level of accuracy and minimise revision rates due to suboptimal implant positioning.

Robotic-arm assisted technology has been used to enhance inpatient recovery and expedite discharge in gastrointestinal, urological, cardiology, and gynaecological surgery. Robotic technology is increasingly
gathering momentum as an avenue for improving rehabilitation in arthroplasty surgery. Kayani et al conducted a prospective cohort study comparing early functional outcomes in 73 conventional manual UKAs followed by 73 robotic-arm assisted UKAs.15 There were no differences in baseline characteristics (age, gender, laterality, ASA, preoperative deformity) between the two treatment groups, surgery was undertaken by a single surgeon using the same approach, and all patients had identical postoperative rehabilitation programmes and discharge requirements. The authors found that robotic-arm assisted UKA was associated with reduced postoperative pain, decreased analgesia requirements, smaller drop in haemoglobin concentration, shorter time to be able to perform a straight leg raise, improved maximum knee flexion at discharge, and reduced need for inpatient physiotherapy compared to conventional jig-based UKA. Mean time to hospital discharge was reduced in robotic UKA compared with conventional UKA (42.5 hours (sd 5.9) vs 71.1 hours (sd 14.6), respectively; p < 0.001). Blythe et al reported a secondary analysis of a randomised controlled trial using robotic-arm assistance versus conventional instrumentation in 139 patients. 16 From the first postoperative day through to week 8 postoperatively, median pain scores for the robotic group were 55.4% lower than those in the conventional group. Hansen et al compared 30 robotic-arm assisted UKAs to 32 conventional UKAs and found robotic group achieved physical therapy clearance 10.3 hours sooner and had 8 hours shorter length of stay than those using conventional UKA, although the former was not statistically significant. 22

Improved pain control, early functional outcomes, reduced physiotherapy, and time to hospital discharge in robotic UKA are important as many arthroplasty centres are now moving towards performing UKA as a day case procedure. These findings suggest that robotic technology may facilitate more widespread adoption of UKA as a day case procedure.

References:
Routine Use Justified

Henry D. Clarke, MD

In primary total hip arthroplasty (THA), data from both Scandinavian national registries and a meta-analysis has demonstrated that the use of antibiotic loaded bone cement (ALBC) is associated with a substantial reduction, estimated to be approximately 50%, in the risk of peri-prosthetic joint infection (PJI) (1,2). Consequently, in many European centers, where cement is still used extensively in THA, use of ALBC has been incorporated into best practices. This trend has also driven the use of ALBC in total knee arthroplasty (TKA). However, the results of studies of ALBC in TKA have been inconclusive and controversy remains. Potential benefits of the use of ALBC in TKA include a reduction in revision due to PJI and even aseptic loosening. Risks include: increased risk of aseptic revision due to mechanical compromise of the cement or local toxicity; systemic reactions; increased costs; and increased antibiotic resistance (3).

In revision TKA, routine use of ALBC appears justified with benefits outweighing risks. Data from the Finish registry has demonstrated a 2.4 hazard ratio (HR) for subsequent PJI when ALBC is not used in conjunction with systemic antibiotics (4).

Results of the benefits of ABLC in primary TKA are mixed and are limited by few randomized clinical trials (RCT). In an early RCT use of ALBC was associated with a statistically significant difference in PJI (0% vs 3%) (5). In a more recent cohort study from a single institution use of ALBC was associated with a reduction of 61% in PJI following primary TKA between 2009 and 2010 versus 2011-2012 (3.3% to 1.3%) (6). However, data from a review of >60K TKA from the New Zealand joint registry demonstrated a greater risk of PJI with an Odds Ratio of 1.93 for PJI when ALBC was used (7). Similar findings were reported in a study from a single US integrated health system with >50K TKA performed between 2001 and 2009 that demonstrated a higher HR of 1.69 for PJI in cases where ABLC was used (8). Recent meta-analysis in 2017 reviewed 7 studies and were also unable to demonstrate a reduction in PJI with ALBC in primary TKA (1.1% ALBC vs 0.9% plain cement) (9). In distinction the Finish registry data demonstrated a 1.4 HR when ALBC was not used in conjunction with systemic antibiotics (4).

Risks of use of ALBC appear to be low. Incorporation of less than 2-3% wt abx/wt cement (i.e. 1gm abx to 40gm batch of cement) does not appear to have a significant clinical impact on the mechanical properties of bone cement, while systemic and local toxicity concerns are also low (3,9). Costs of use of ALBC are driven by the reduction in PJI, and the costs of treatment for PJI. ALBC in the US doubles or triples price of cement. In one series, the cost benefit would be noted if treatment for each case of PJI is between ~$2K and $110K (11). In the cost analysis from a single European center use of ALBC was associated with an absolute cost reduction of ~800 Euros per patient when costs of treating PJI was included (6). Finally, risk of antibiotic resistance from studies performed at two institutions appears to be low, with no change in incidence of resistant organisms before and after implementing use of ALBC (6,12).

Routine use of ALBC appears prudent in revision TKA and high-risk patients in primary TKA. Use in all patients undergoing TKA is controversial but can be justified where costs of treating PJI are high, patient risk factors are high, and infection rates are elevated as the risks appear to be low.
References:
10. King JD et al: The hidden costs…J Arthroplasty 33:3789-3792, 2018
There is still considerable controversy regarding the routine use of antibiotic-loaded bone cement (ALBC) during primary TKA. This is in distinct contrast to the literature for ALBC use in hip arthroplasty, revision knee arthroplasty or two-stage revision for infection where available data suggest clinical efficacy and economic benefits.

Somewhat surprisingly, there are only several randomized trials of ALBC use in primary TKA and there are relatively few studies suitable for meta-analysis to answer the question of whether or not the routine use of ALBC in primary TKA is warranted for all patients. Many non-randomized articles attempting to evaluate this topic have too few patients or do not adequately stratify healthy patients from high-risk patients or use historical controls.

Some concerns for routine use of ALBC in primary TKA include: 1) allergy or toxicity to the antibiotic being used, 2) reduction in mechanical properties of bone cement, or 3) emergence of antibiotic-resistant bacteria. Although it is recognized that the occurrence of these adverse reactions is extremely low, in the absence of proven clinical efficacy, there is no logical rationale for routine use of ALBC in primary TKA. Likewise, in the absence of proven clinical efficacy, the extremely high economic costs of ALBC are not justified.

All recent meta-analyses, including secondary analysis of only randomized trials, conclude that there are insufficient data to support the routine use of ALBC in primary TKA and that research should focus on identifying and studying the high-risk patients (immunocompromised, morbidly obese, diabetic, or previous history of fracture or infection of the knee joint) in whom there is a logical rationale to justify its use.

Finally, it should be recognized that the use of ALBC for prophylaxis in primary TKA is not FDA approved and as such, use of ALBC should not be routine but used only sparingly when it is deemed necessary for an individual high-risk patient.
References

Fully Cemented Stems Technique: Rationale and Results
David G. Lewallen, MD

The use of stems during revision TKA helps provide enhanced mechanical support and adjunctive fixation to the often damaged bone of the metaphysis for components on both the femoral and tibial side. As a result, stem use has become routine for the vast majority of revision cases as results are more durable when stems are used. (1) Stems may be long and of any of a variety of cementless designs that are diaphyseal engaging, or stems may be fully cemented and usually short to intermediate length (30 to 75 mm). It is important to NOT USE either short “dangling” cementless stems that fail to engage the diaphysis or very long cemented stems. Both techniques should be avoided: the former short cementless stems due to inadequate fixation and high rates of implant loosening, and the latter very long cemented type because removal can be extremely difficult and damaging to the bone should infection occur. Used with proper technique and stem design, durable fixation has been reported with both cemented and cementless stem use. (2)

The reliability of both methods has been increased dramatically by the now widespread use of cementless cones or sleeves that provide the potential for bone ingrowth in the metaphyseal area and reduced loads over time to the areas of cement fixation used in both methods and improved long term implant fixation as a result. The purpose of short to intermediate length cemented stems is to enhance the initial fixation provided by cementation of the femoral housing or tibial tray to the host bone long enough to allow bone ingrowth to occur to the companion sleeve or cone. The goal is a motionless implant bone interface over the initial few months post surgery. Once bone ingrowth to the sleeve or cone occurs it is protective with a reduction in loads at the cement bone interface long term. This combined approach of cemented stem plus cementless cone use has proven effective for both femoral and tibial side fixation at midterm follow-up in what are selected series of more severe bone loss cases. (3, 4)

Our preference currently when cemented stems are used highly porous metaphyseal cones currently is for the stems to extend around 2 to 4 cm beyond the cone, as this has proven to be sufficient for this initial fixation strategy. Cemented stems of this length avoid long cement columns and are very removable should this be required due to infection or revision. Longer stems (cemented or cementless) can be reserved for cases of very extreme bone loss, impaired bone quality, fracture or simultaneous osteotomy. The total length of the tibial or femoral stem that is cemented with this method is currently often nearly identical to the level of metaphyseal cement advocated by most proponents of long cementless stems. However the big advantage of shorter fully cemented stems is the ability to achieve better cement technique by plugging the canal and pressurization of the cement. This is very difficult to achieve when partially cementing a long stem into an open canal.

It has been noted that one advantage of the long cementless stem method is that proper alignment is facilitated by the diaphyseal engagement of the components. However, it is actually quite easy to adapt this technique to the short cemented stem method by using diaphyseal engaging instruments and trials to prepare the bone and finalize implant orientation and positioning before final cementing of the short stemmed real components. Alternatively, short stem trials can be used with an intraoperative x-ray to ensure desired alignment and implant position before cementation of the real components. With these methods, cemented stem extensions of 30 to 75 mm used in combination with metaphyseal cones or sleeves allow reliable and durable reconstruction of over 95% of revision TKA encountered while preserving the possibility of reasonable host bone preservation and greater ease of implant removal should this be required. (5)
References


Hybrid Fixation Technique and Results
Keith Berend, MD

Background: The two most common techniques for achieving implant fixation during revision TKA are hybrid fixation or fully cemented [1]. Hybrid fixation allows the surgeon the benefit of stable fixation with the use of metaphysis engaging / diaphyseal press-fit stems, while also achieving surface fixation with cement. Avoiding cement in the canals can aid in the ease of future surgery as well as minimize intraoperative medical complications associated with cement pressurization of canals. Fully cementing a revision TKA can also increase operative time by 17 minutes over hybrid fixation [2].

Operative Technique for Hybrid Fixation: The intramedullary canals are sequentially reamed until a clinical “press-fit” is achieved. The final stems will fit tighter than trials. Different implant systems have a varying amount of press-fit, but typically 0.5mm to 1.5mm. Cement is applied to the non-stem portions of the implant, the cut bony surfaces immediately adjacent to the implant, as well as to the metaphysis. Cement is avoided in the canal as to not interfere with biologic fixation of the stem.

Outcomes: Numerous studies have shown that hybrid fixation produces durable lasting results in revision TKA [3-8]. Chon et al compared hybrid to fully cementing in 115 TKA revisions and found no difference in revisions due to aseptic loosening or any other cause up to 10-year follow up. Furthermore, clinical outcomes, knee ROM, Knee Society clinical scores, Knee Society functional scores, and pain scores were not statistically different between the hybrid and fully cemented prostheses [4]. Heesterbeck et al. demonstrated no difference in clinical scores or implant micromotion between fully cemented and hybrid fixation at 2 years [6]. Other studies have not only shown equivalence, but improved long-term survivorship with hybrid fixation over fully cemented [2]. Hybrid fixation has demonstrated survivorship of 100% at 5 years [7, 8] and 90% at 10 years [7]. Age rather than fixation technique has been shown to be the greatest risk factor in revision TKA mechanical failure [9].

Discussion: Hybrid fixation is a safe and robust option in revision TKA with equivalent if not improved long-term survival over fully cemented technique. Hybrid fixation gives the surgeon the advantage of ease of implantation as well as being bone preserving if re-revision is needed.
References:
Porous metaphyseal cones have emerged as a useful method to provide structural support for tibial and femoral implants as well as filling larger bone voids in revision TKA\textsuperscript{1-8}. Short- and medium-term evidence now exists that supports the use of these implants in the reconstruction of large tibial and femoral defects in revision total knee arthroplasty.\textsuperscript{1-7,9}

Early outcomes with highly porous metaphyseal tantalum cones utilized in large tibial defects for revision total knee arthroplasty have been reported by multiple authors.\textsuperscript{6,7} Meneghini et al reported a series of fifteen revision knee arthroplasties that were performed with a porous tantalum metaphyseal tibial cone and were followed for a minimum of two years. All tibial cones were found to be osseointegrated radiographically and clinically at final follow up with no reported failures.\textsuperscript{6} In a series of sixteen revision total knee arthroplasties with severe tibial defects, Long and Scuderi reported good results with osseointegration of the porous tantalum cone 14/16 cases at a minimum 2-year follow up.\textsuperscript{7} Similar results have been reported in the femoral version of the porous tantalum metaphyseal cones.\textsuperscript{2-4} Howard et al reported on twenty-four femoral porous tantalum cones in complex revision total knee arthroplasty and found no radiographic failure or loosening at a minimum two years follow up.\textsuperscript{4}

Longer-term results are also available with highly porous tantalum metaphyseal cones, and have demonstrated continued good results.\textsuperscript{1,9} Kamath et al. recently reported on 66 highly porous tibial metaphyseal cones used in Type 2 and 3 AORI tibial defects. At a minimum 5-year follow-up, the authors report one revision for aseptic loosening and one radiograph with progressive radiolucencies concerning for fibrous ingrowth with a greater than 95\% revision-free survivorship at latest follow up.\textsuperscript{1}. Potter and colleagues reported mean 5-year survivorship from aseptic cone loosening of 96\% in 159 tantalum metaphyseal femoral cones implanted in 157 patients.\textsuperscript{9}

Novel porous titanium metaphyseal cones were designed specifically to maximize surgical efficiency through an optimal geometric fit derived from an extensive anatomical CT database and in conjunction with streamlined reamer-based instrumentation that effectively eliminates non-instrumented manual high-speed burring that is laborious and time-consuming.\textsuperscript{10} We recently reported our initial results with these novel metaphyseal cones, which is a retrospective review of a prospectively collected database between 6/2015 and 7/2017. Tibial bone loss was classified using the AORI classification. Sixty cones were implanted in 58 patients. Tibial bone loss was classified as IIA in 27/60 cases (45\%), IIB in 15/60 cases (25\%), and III in 18/60 (30\%). Average radiographic follow-up was 1.5 years (1.0-2.7 years) and 96\% of cones demonstrated radiographic osseointegration. No re-revisions for tibial component loosening occurred. Early radiographic results of an additive manufactured porous titanium cone implanted with a novel ream-preparation technique demonstrated excellent ingrowth in 96\% of complex revision TKAs with significant tibial bone loss. The novel
ream-preparation technique may enhance bone apposition, osseointegration and simplicity, as well as surgical efficiency and reproducibility. While our early results are promising, longer follow-up is warranted.

References

**Knee Arthrodesis: Current Indications and Techniques**

*Thomas K. Fehring, MD*

Knee arthrodesis at one time was the gold standard for infected total knee arthroplasty. However, the results of staged reconstruction for infection, as well as, the multiple reconstructive options available today have obviated its frequent use. In fact in a study from the Danish Knee Registry of nearly 100,000 total knees over 15 years showed an incidence of arthrodesis for salvage of less than 1%. The indications for knee arthrodesis can be broken down into definite indications or relative indications. The definite indications for arthrodesis include:

1. Extensive soft tissue loss,
2. Non-functional quad mechanism due to neural compromise or atrophy,
3. Extensor mechanism deficiency coupled with infection,

In a multicenter study of 53 patients comparing extensor mechanism deficiency in prosthetic joint infection 41 of 53 or 77% were considered failures. The authors concluded that early fusion may be preferable in this situation (1). In contrast in a small series of 16 patients from the Mayo Clinic using a two-stage exchange coupled with Marlex Mesh reconstruction noted 75% success at two year follow up (2). Patient preference must be taken into account when making decisions on whether or not to fuse the knee. Multiple unsuccessful attempts at surgery can lead patients to prefer a definitive solution through the use of arthrodesis despite its functional shortcomings.

Relative indications for knee arthrodesis include:

1. Myelopathic process with arthritis,
2. Young manual labor with limited education,
3. 3rd world solution for a primary problem,
4. Failed extensor mechanism reconstruction,
5. Failed two-stage procedure in a comorbid patient.

In a study of 45 patients with two or more failed two-stage procedures compromised hosts (MSIS type C) had a 75% failure rate, while uncompromised hosts (MSIS type A) patients had a 70% success rate. The authors recommended considering arthrodesis in compromised hosts who had failed two or more two-stage procedures (3). Additionally, in a systematic review concerning failed two-stage reimplantation other authors concluded that knee arthrodesis would be the treatment most likely to yield the highest quality of life after a failed two-stage (4).

Techniques for arthrodesis include:

1. External fixation
2. Long Intramedullary rod
3. Short intramedullary rod
4. Intercalary rod
5. Double plating

External fixation results have shown a high prevalence of non-unions and complications; while intramedullary rods seem to have a much higher rate of solid fusion. In a comparison between external fixation and intramedullary rods 23 of 24 intramedullary techniques resulted in a solid fusion while only 41 of 61 external fixator cases fused (5). Similar infection rates were noted (6). A systematic review and meta-analysis of the literature came to a similar conclusion noting that IM nails achieve significantly higher rates of union with no
difference in the rate of recurrent infection (7). Intercalary IM rods are a new alternative which provide an
arthrodesis in cases where bone loss is significant and allows preservation of limb length. Results of this
technique are encouraging but only 2-3 year results are available at this time (8 and 9). Double plating has
been used with success in a few small series; however it is important that the plates should be placed 90
degrees from each other to counteract out of plane forces, while staggering the plates to prevent stress
concentration (10). This technique is most applicable in fungal or resistant organism infections with a high
recurrence risk where the chance of having to remove the hardware at a later date is high. This is relatively
easy with the double plating technique but is very difficult with some of the intramedullary implants.

Most algorithms for dealing with these significant problems for infection involve a two-stage process where a
static spacer is placed or a temporary fusion with Steinman pins is done if soft tissue coverage demands
shortening to obtain wound closure. My personal algorithm for knee arthrodesis includes a two-stage
approach. If there is adequate bone for fixation I prefer a short IM rod that can be accessed through the knee. I
avoid long IM rods because of the increase blood loss and propensity for tibial fractures due to difficulty
matching the exact sagittal curve of the bone. I reserve intercalary fusion nails for significant bone loss cases
where arthrodesis is indicated and reserve double plating techniques for those patients with good bone where
the risk of recurrence is high due to a fungal or resistant organism infection.
Session VII: Lessons Learned From the Legends

3:04 – 3:10 pm

Case 1

Robert E. Booth, Jr., MD (Philadelphia, PA)

While each of us could pick a seminal case from which we learned or reaffirmed many of the lessons we have acquired over our careers, the variety of knee arthroplasty is so great that perhaps this revisional opportunity will serve as a vector for deeper thoughts. In the evaluation of failed total knee arthroplasties, we now have diagnostic techniques which have exceed our surgical techniques for resolution of the patient's problem. As a surgeon, one earns one's living doing primary and straightforward knee replacements, but one gamers one's education and reputation by doing revisional total knees. Hence this brief discussion will focus on lessons learned from revisions.

There is always more than one problem. While a single major error may undo a total hip, it takes multiple problems to produce a poor total knee result. Hips are a ball and a socket, which can be inserted independently, while a knee has multiple components - all of whose insertion is dependent upon the prior step in the procedure. Thus, simple polyethylene exchanges - or even single-sided revisions or pure patellar revisions - have been shown to have a low level of success.

Despite the enthusiasm for customized instruments, customized components, computer guided instruments, and even robotics, the surgeon remains the critical ingredient in a successful total knee. Part of this because we still must adhere to the primary principles of soft tissue balancing, which are diminishing in our measured-resection and image-guided techniques of knee replacement. Interestingly, each of us has our own pattern of errors (regardless of our technique), and we tend to commit the same errors repetitively.

From a mechanical standpoint, the principles of knee revision were best annunciated years ago by John Insall, Kelly Vince, and myself in a small pamphlet which not only described the generic issues of knee revision, but more importantly the three-step pattern (Vince) and the matrix of decision making (Booth) that still guide us today. We have learned that we are best off doing an entire knee replacement, not just a partial one. We have learned that soft tissue balancing is still the definitive issue in a septic revision. We have learned that custom implants and custom instruments serve us no better -yet at greater expense - than existing techniques. Interestingly, we tend to ignore the international registries that we revere and often do not use the components that they would recommend.

We have learned that delay is rarely to our advantage in dealing with unsatisfactory knee arthroplasties. The infected knees become incurable, while the uninfected knees become worse. Stiff knees get stiffer, loose knees get looser.

On the other hand, we must, as surgeons, remember that there is not necessarily a surgical solution to every problem. There is no knee so bad that we can't make it worse with yet another operation. Most particularly, one should not perform procedures which, if they fail, we ourselves cannot reverse. For economic and sociologic reasons, it is becoming increasingly difficult to find individuals or institutions who are enthusiastic about taking on other surgeons' failed arthroplasties.

From a biologic standpoint, our ability to identify infection and to separate the great divide between septic and aseptic failures is unquestionably better than it has ever been. Alfa Defensin, in particular, has been a milestone in this effort. Alternatively, our techniques for revision of septic arthroplasties in particular have advanced minimally, and this still remains an embarrassingly weak area of our art.
We have learned that surgical time may be one of the most essential aspects of our surgery. A 90-minute primary total knee has roughly three times the incidence of infection and DVT as a 30-minute total knee. For revision knees, multi-hour surgeries and multiple tourniquet times often lead to parlous results.

From a psychological standpoint we need to remember that our patients with a failed total knee have now lost their faith in the majesty of medicine. They need extra attention, extra time, and more empathy. While one should hang crepe before the procedure, one should never criticize the prior surgeon - even with a raised eyebrow - about the reasons for failure. It takes a true team to reverse a failed total knee, and we must remain mutually congenial and supportive.
How Big is the Problem?
Bryan D. Springer, MD

Total joint arthroplasty of the hip and knee are two of the most successful surgeries in all of medicine. Long-term data suggests significant improvement in pain, function and quality of life with an overall low morbidity and mortality. The utilization of total hip and knee arthroplasty continues to rise. Yet there remains a certain sector of the population with debilitating arthritis who chose to avoid having surgery for fear of complications. One of the most common reasons for avoiding surgery is fear of pain from the surgery itself and during the recovery period.

In the early 2000’s a concerted effort was made by organizations such as The Joint Commission so that the assessment of and the treatment of pain was more visible. Thus pain became “the 5th vital sign”. Coupled with aggressive marketing of the pharmaceutical industry on the safety and non-addictive nature of opioids, they become the dominant pain management strategy for over a decade. Nowhere has this been more evident that in the United States where we represent approximately 20% of the world’s population but account for over 80% of opioids prescriptions written. Orthopaedic Surgery is no exception to this. Our specialty is the second leading prescriber of opioids in the United States.

This aggressive utilization of opioid medication to treat both arthritis and postoperative pain has no doubt helped to fuel the opioids epidemic in the United States. From 1999-2006, greater than 200,000 people have died in the US from overdoses related to prescription opioids. The preoperative and postoperative utilization of opioids medications is associated with a high risk of dependency, addiction, diversion and death. In total hip and knee arthroplasty, the preoperative use of opioids is associated with higher dissatisfaction and a higher rate of complications and revision surgery compared to opioids naïve patients.

Fortunately as a response to this epidemic, orthopaedic surgeons and in particular arthroplasty surgeons have been leading the way in developing multi-modal pain management strategies to reduce the dependency on opioids medication both before and after total joint arthroplasty. These strategies rely on the reduction or elimination of preoperative opioids use as well as the utilization of non-narcotic medications and other modalities (nerve blocks and periarticular injections) to reduce the dependency on narcotic pain medications.
Post-Operative Management  
Craig J. Della Valle, MD

As hospital length of stay following adult reconstructive procedures has decreased, controlling pain in the perioperative period has become more challenging. Further, with an emphasis on reducing narcotic consumption, we have become more sophisticated in our methodologies relying on a combination of medications used together.

The basics of the post-operative regimen we use include:

- A long-acting anti-inflammatory medication. Our preference is Meloxicam as it is:
  - A once daily medication that is available as a generic
  - Well tolerated by most patients
- We tell patients that Acetaminophen should be their first line pain medication
  - Inexpensive, over the counter medication
  - Well tolerated and familiar to patients
- Tramadol is in general used as our second line for pain control
  - Available as a generic
  - Lower side effect profile than traditional narcotics
- Oxycodone IR is given (30 tablets) to use as a “last resort” for pain control
  - Our preference is to uncouple the use of acetaminophen and the narcotic pain medication to optimize the analgesic properties of acetaminophen while decreasing the need for opioids.
  - In a recent RCT performed at our center comparing an Rx for 30 vs. 90 tablets we found that patients who received 30 tablets had equivalent pain scores and satisfaction yet far fewer tablets left over (which are ripe for potential abuse). They also consumed less narcotics, although they did require slightly more frequent refills. We did find however, that most patients can be safely discharged with an Rx of only 30 tablets.
- A nerve stabilizing agent such as Neurontin is also utilized
  - Its biggest benefit may be a lower risk of chronic neurogenic pain, particularly after knee procedures
  - We prefer Neurotin over other agents such as Lyrica as it is available as a generic and hence easier for patients to obtain.

It is important to keep in mind that complicated regimens can be confusing for patients. We have found that frequent phone calls to the patients to review how they are doing with pain control soon after discharge is helpful. At this time, we review our suggestions for medication usage and seek to identify unwanted side effects or barriers to appropriate medication use.

Finally, it is important to ensure that patients know how to safely dispose of left over narcotic pain medications as these can lead to narcotic abuse.
Once diagnosed, chronic PJI has been traditionally been treated with a two-stage resection and reimplantation, while acute PJI is typically treated by the majority of surgeons with a debridement and component retention, particularly in cemented TKA. When cementless fixation is used in TKA, and more commonly in THA, a two-stage resection and reimplantation may be advocated in the acute PJI setting due to the relative ease in removing the implants before ingrowth. More recently, some have been advocating for a one-stage resection and reimplantation of the final implants during the same anesthetic in acute hip PJI.1-6 Based on the existing literature, one-stage exchange success rates range from 70-94.5%, while two-stage resection success rates range from 85-100%.2,7-12 An intriguing technique of two-stage component retention in hip and knee PJI involves initial I&D with insertion of high-dose antibiotic beads and exchange of modular parts, with a repeat debridement and removal of beads and insertion of final implants 5-7 days later with long-term IV antibiotics and has mid-term success rate of 90%.13 Patients with a history of prior procedure, prior debridements, and prior open surgery have a higher risk of treatment failure with respect to PJI 14. Additionally, other research has shown that patients who fail initial two-stage treatment for PJI have a reduced rate of cure with subsequent surgeries, and the risk for reinfection is high at 42% 15. Thus, in order to achieve the optimal functional outcome, it is essential to treat PJI successfully at first presentation and reduce the risk of subsequent intervention.

Increasingly more surgeons have adopted the use of a one-stage exchange for THA PJI patients with minimal co-morbidities infected with known organisms of relatively low-virulence and sufficient bone quality 1-5,16. Zeller et al. created a decision tree to aid in the choice between debridement, one-stage exchange, and two-stage exchange. One-stage exchange was selected for patients with ASA < 3, symptom duration longer than 2 weeks, in the setting of a stable prosthesis that was implants > 1 month prior. Additional criteria required that there be no severe bone loss and a preoperatively isolated organism. Patients found to have a fungal infection or a difficult-to-treat organism were not eligible for one-stage treatment 16.

A significant challenge when interpreting the existing literature on the success of one and two-stage treatment options for hip PJI is the lack of standardized treatment protocols within the studies, creating numerous confounds that make data analysis and interpretation of outcome superiority between the two approaches extremely difficult. Recently, authors from Mayo Clinic published one of the longest term and scientifically rigorous reports on outcomes after two-stage exchange after hip PJI.10 They authors state the main limitation of the study was the lack of standardization in the two-stage exchange protocol.10

The authors recently reviewed a consecutive series of patients with PJI after THA, including chronically infected hosts, treated with a contemporary, evidence-based standardized two-stage resection and reimplantation THA protocol with respect to reinfaction rates and outcomes. 55 consecutive two-stage resection and reimplantation THAs for PJI between 2011 and 2017 were retrospectively reviewed. Patients were categorized with McPherson’s Staging System and infection defined by MSIS criteria. Contemporary standardized protocols were strictly adhered to including implant resection, meticulous debridement, high-dose antibiotic spacer, 6-week intravenous
antibiotics, two-week drug holiday, and laboratory assessment of infection eradication prior to reimplantation. Extended antibiotics after reimplantation were not routinely used. Successful treatment was defined as reimplantation with component retention at minimum two-year follow-up. After exclusions for confounds, 48 of 52 patients had obtained minimum two-year follow-up (mean 57.2 months). 41.6% were chronically infected poor hosts (Stage III-B/C). Three patients required repeat debridement and/or spacer exchange prior to final reimplantation. Treatment success rate was 95.8% at two-year follow-up and both failures occurred in the late chronic PJI group (stage III). Our success rate with the two-stage procedure equals or exceeds single-stage treatment, in an unselected cohort of chronically infected poor hosts. More rigorous scientific studies are warranted prior to indiscriminate adoption of the single-stage treatment approach for PJI in THA and the two-stage approach should remain the gold standard in the treatment of chronic PJI.

References
Periprosthetic joint infection remains one of the most devastating complications following joint replacement today. If one looks at the scope of periprosthetic infection this problem has increased exponentially over the years just as the frequency of total hip and total knee procedures has increased. It has been projected that in 2020 49,000 prosthetic joint infections would require treatment in the US alone with a projected cost of $1.6 billion (1). Hospital charges for infected hip arthroplasties are 1.7 times greater than that of uninfected arthroplasties (1). The mean cost to treat an infected hip was $6,000 greater than treating infected total knees (2). Prosthetic joint infections have significantly longer hospitalizations, more readmissions, more clinic visits, and four times the mean annual cost (3). If one looks at the direct and indirect cost to society of prosthetic joint infection one notes that when you take lost wages into consideration and reinfection rates are added to the direct hospital cost tremendous cost are incurred. A 65 year old with a prosthetic joint infection costs $389K to society, while a 55 year old with prosthetic joint infection costs $474K (4).

Unfortunately, the current reimbursement models for the treatment of infection are typically not reimbursed fairly placing the burden of care on the physician and the hospital (5).

Little progress has been made in reducing the incidence of prosthetic joint infection with prevalence hovering at 1-2%. Optimizing the patient preoperatively is one improvement strategy. One-stage treatment for prosthetic joint infection is another attractive strategy to decrease hospital costs in contrast to a two-stage procedure. Unfortunately studies comparing one-stage and two-stage procedures are lacking. In a systematic review of the literature comparing one-stage or two-stage procedures 1,128 studies were reviewed; the overall quality of the studies were poor and the authors recommended a high quality randomized study be performed (6). Because of the projected cost of treating periprosthetic infection health economics mandates an investigation concerning one-stage procedures.

To that end a prospective, randomized, multicenter study excluding only fungal organisms and immunosuppressed patients has been initiated at 15 sites in the US. The protocol for these procedures includes re-prepping and re-draping between stages. All hosts are classified according to MSIS criteria. The data set necessary to have adequate power to determine which is superior is 309 patients. 135 patients have been enrolled to date. The protocol for the one-stage procedures is time intensive requiring a double instrument set up, re-prepping, and re-draping between stages requiring significant transition time between stages. Intraoperative service time for these procedures is significant. However, if the results of one-stage vs two-stage are similar significant economic savings will be realized. A salient question exists - If the results of one-stage vs. two-stage are similar will surgeons be discouraged from performing one-stage procedures that have patient and societal benefit because reimbursement is inadequate?

We studied the reimbursement and intraoperative service time for one-stage procedures compared to primary surgery. 51 one-stage procedures were compared to 250 primary total hips and 250 primary total knees at the OrthoCarolina Hip and Knee Center. Coding was performed via AAOS guidelines. We found that reimbursement per hour for primary total hip was $1,589.00 while reimbursement per hour for a one-stage infected hip procedure was $545.00 - lost revenue of $1,044/per hour. Likewise a primary total knee was reimbursed at $1,461.00/hour where a one-stage total knee procedure was reimbursed at $601.00/hour- lost revenue in this case was $860.00/hour. We concluded that one-stage procedures are reimbursed at approximately 1/3 the hourly rate of a primary arthroplasty. This fact may discourage surgeons from selecting this treatment alternative if studies currently ongoing confirm efficacy of one-stage treatment. Payers should be encouraged to reimburse physicians commensurate with intraoperative service time. If the results of one-stage are shown to be positive adoption will decrease morbidity and save the healthcare system financially. Therefore fair reimbursement is critical.
CME ACCREDITATION STATEMENT
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 Knee Society. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

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Upon completion of this activity, participants will be able to:
• Update clinical skills and basic knowledge through research findings and biomechanical studies.
• Discuss the various surgical and non-surgical treatments and management of conditions related to the knee joint.
• Determine indications and complications in total knee arthroplasty.
• Critique presentations of surgical techniques and demonstrations of treatment options.
• Evaluate the efficacy of new treatment options through evidence-based data.

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Some pharmaceuticals and/or medical devices at the Specialty Day Meeting have not been cleared by the U.S. Food and Drug Administration (FDA) or have been cleared by the FDA for specific purposes only. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each pharmaceuticals and/or medical devices he or she wishes to use in clinical practice.

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THE KNEE SOCIETY EDUCATION COMMITTEE:

**Ryan M Nunley, MD** (Saint Louis, MO) Submitted on: 10/22/2018 AAOS: Board or committee member; American Association of Hip and Knee Surgeons, Board of Directors and Treasurer: Board or committee member; Biocomposites: Paid consultant; Biomet: Research support; Cardinal Health: Paid consultant; DePuy, A Johnson & Johnson Company: Paid consultant; Research support; Halyard: Paid consultant; Hip Society: Board or committee member; Medical Compression System Inc: Paid consultant; Medical Compression Systems, Inc.: Research support; Medtronic: Paid consultant; Microport: IP royalties; Paid consultant; Mid-America Orthopaedic Association, Program Committee Chair, 2018 Program Chair: Board or committee member; Mirus: Paid consultant; Missouri State Orthopaedic Association, Board Member and President: Board or committee member; Smith & Nephew: Paid consultant; Research support; Southern Orthopaedic Assoc. 2018 President: Board or committee member; Stryker: Research support The Knee Society, Education Committee, 2018 Program Chair: Board or committee member

**Bryan Donald Springer, MD** Submitted on: 10/02/2018 AJRR: Board or committee member; Arthroplasty Today: Editorial or governing board; Ceramtec: Paid presenter or speaker; Convatec: Paid consultant; ICJR: Board or committee member; Joint purifications systems.: Other financial or material support; Journal of Arthroplasty: Editorial or governing board; Knee Society: Board or committee member; osteoremedies: Paid consultant; Stryker: IP royalties; Paid consultant

**Keith R Berend, MD** (New Albany, OH) Submitted on: 04/26/2018 Clinical Orthopaedics and Related Research: Editorial or governing board; Elute, Inc.: Stock or stock Options; Joint Development Corporation: Stock or stock Options; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Editorial or governing board Knee Society: Board or committee member Orthopedics: Editorial or governing board; Reconstructive Review: Editorial or governing board; SPR Therapeutics, LLC: Research support; Stock or stock Options; Zimmer Biomet: IP royalties; Paid consultant; Research support

**Craig J Della Valle, MD** (Chicago, IL) Submitted on: 09/03/2018 American Association of Hip and Knee Surgeons: Board or committee member; Arthritis Foundation: Board or committee member; DePuy, A Johnson & Johnson Company: Paid consultant;Hip Society: Board or committee member; Knee Society: Board or committee member; Mid America Orthopaedic Association: Board or committee member; Orthopedics Today: Editorial or governing board; Parvizi Surgical Innovations: Stock or stock Options; SLACK Incorporated: Editorial or governing board; Publishing royalties, financial or material support; Smith & Nephew: Paid consultant; Research support; Stryker: Research support; Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support; Zimmer: IP royalties; Paid consultant; Research support;

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**Timothy M Wright, PhD** (New York, NY) Submitted on: 04/23/2018 Exactech, Inc: IP royalties; Knee Society: Board or committee member; Lima: IP royalties; LimCorporate: Research support; Mathys Ltd: IP royalties; Orthobond: Stock or stock Options; Stryker: Research support
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Keith R Berend, MD (New Albany, OH) Submitted on: 04/26/2018; Clinical Orthopaedics and Related Research: Editorial or governing board; Elute, Inc.: Stock or stock Options; Joint Development Corporation: Stock or stock Options; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Editorial or governing board; Knee Society: Board or committee member; Orthopedics: Editorial or governing board; Reconstructive Review: Editorial or governing board; SPR Therapeutics, LLC: Research support; Stock or stock Options; Zimmer Biomet: IP royalties; Paid consultant; Research support

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James Andrew Browne, MD Submitted on: 01/06/2019 American Association of Hip and Knee Surgeons: Board or committee member; American Joint Replacement Registry: Board or committee member; DJ Orthopaedics: IP royalties; Paid consultant; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Publishing royalties, financial or material support; Norvartis: Paid consultant; OsteoRemedies: Paid consultant; Radlink: Stock or stock Options; Saunders/Mosby-Elsevier: Publishing royalties, financial or material support; Southern Orthopaedic Association: Board or committee member; Virginia Orthopaedic Society: Board or committee member

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Cynthia Garcia (Rosemont, IL) (This individual reported nothing to disclose); Submitted on: 11/08/2018

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