The 2017 Specialty Day Program
of The Knee Society

In association with the
American Association of Hip and Knee
Surgeons (AAHKS)

FINAL SCIENTIFIC PROGRAM

Saturday—March 18, 2017
San Diego Marriott Marquis & Marina
Marriott Grand Ballroom 8
IMPORTANT!

Ready. Set. Respond.

The following sessions of The Knee Society/AAHKS Specialty Day programming will utilize the Audience Response System (ARS) feature of My Academy app:

- Session V
- Session VI

We Are Streaming Live

This program is streaming live in its entirety. The live stream is not accredited for CME. Everyone who is registered to attend the program in person receives complimentary access to the live stream, and to the archived content, for one year, through March 10, 2018.

Questions?

Email knee@aaos.org or call (847)698-1638

Thank you for attending our 2017 Specialty Day programming!

We hope to see you in 2018 in New Orleans!
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/KSSD2017 or use the QR code to access with your handheld smart device:

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.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detailed schedule</td>
<td>13</td>
</tr>
<tr>
<td>Abstracts</td>
<td>24</td>
</tr>
<tr>
<td>Orthopaedic disclosures</td>
<td>93</td>
</tr>
<tr>
<td>The Hip Society’s program</td>
<td>reverse</td>
</tr>
</tbody>
</table>

---

**Join Us In New Orleans!**

The 2018 AAOS Annual Meeting and Specialty Day

March 6-10, 2018
ACKNOWLEDGEMENTS

Past Presidents of The Knee Society

1983  Chitranjan S. Ranawat, MD
1984  Chitranjan S. Ranawat, MD
1985  Richard S. Bryan, MD (Deceased)
1986  John N. Insall, MD (Deceased)
1987  Charles O. Townley, MD (Deceased)
1988  David G. Murray, MD
1989  Frederick C. Ewald, MD
1990  Lawrence D. Dorr, MD
1991  Herbert Kaufer, MD
1992  Paul A. Lotke, MD
1993  Leonard Marmor, MD (Deceased)
1994  David S. Hungerford, MD
1995  Richard D. Scott, MD
1996  Victor M. Goldberg, MD (Deceased)
1997  W. Norman Scott, MD
1998  James A. Rand, MD
1999  Kenneth A. Krackow, MD
2000  Thomas S. Thornhill, MD
2001  Clifford W. Colwell, Jr., MD
2002  Robert E. Booth, Jr., MD
2003  Cecil H. Rorabeck, MD
2004  Merrill A. Ritter, MD
2005  Russell E. Windsor, MD
2006  Gerard A. Engh, MD
2007  Michael A. Kelly, MD
2008  Douglas A. Dennis, MD
2009  William L. Healy, MD
2010  Arlen D. Hanssen, MD
2011  Robert B. Bourne, MD, FRCSC
2012  Giles R. Scuderi, MD
2013  Steven J. MacDonald, MD, FRCSC
2014  Thomas K. Fehring, MD
2015  Thomas P. Vail, MD

Past Presidents of AAHKS

1991  J. Phillip Nelson, MD (Deceased)
1992-1993  Chitranjan S. Ranawat, MD
1994  Richard C. Johnston, MD, MS
1995  Lawrence D. Dorr, MD
1996  Hugh S. Tulloss, MD (Deceased)
1997  Merrill A. Ritter, MD
1998  Richard H. Rothman, MD, PhD
1999  James A. Rand, MD
2000  Richard B. Welch, MD
2001  John J. Callaghan, MD
2002  Douglas A. Dennis, MD
2003  Clifford W. Colwell, Jr., MD
2004  Richard F. Santore, MD
2005  Joseph C. McCarthy, MD
2006  William J. Hozack, MD
2007  Daniel J. Berry, MD
2008  David G. Lewallen, MD
2009  William J. Robb, III, MD
2010  Mary I. O'Connor, MD
2011  Carlos J. Lavernia, MD
2012  Thomas P. Vail, MD
2013  Thomas K. Fehring, MD
2014  Brian S. Parsley, MD
2015  Jay R. Lieberman, MD
Did We Hit The Mark?

In 2016, in Orlando, we conducted a comprehensive and focused survey to redefine the value and success of our Specialty Day programming. We carefully analyzed your comments, critique, and suggestions. **We have implemented many of your suggestions when planning the 2017 Specialty Day program**, including:

1. Topics of interest to our participants have been incorporated.
2. Session times are closely coordinated with The Hip Society.
3. Complimentary boxed lunch will be provided to all registered participants.
4. We will be using the Audience Response System through the Academy App.
5. We will be presenting one combined session on value, quality, and economics at the end of the day.

**Tell us what you think.** Complete the survey that will be handed out, and return it to any staff member before you leave. Thank you for your thoughts!
Contemporary Approaches to Adult Hip and Knee Reconstruction

Presented by The Hip Society and The Knee Society

PROGRAM HIGHLIGHTS:
- Small group case-based format
- Close interaction with world-renowned faculty
- Key primary hip and knee arthroplasty concepts
- Avoid and manage potential complications
- Unicompartmental knee arthroplasty, outpatient arthroplasty, bundled payment models
- Expert panel on modern perioperative management
- Video vignettes of select surgical techniques and tips

PROGRAM CO-CHAIRS:
R. MICHAEL MENECHINI, MD  Indianapolis, IN
SCOTT M. SPOKER, MD  Chicago, IL

SPECIAL GUEST SPEAKER:
WILLIAM N. CAPELLO, MD

PROGRAM FACULTY:
KEVIN L. GARVIN, MD  Omaha, NE
DAVID G. LEWALLEN, MD  Rochester, MN
JOHN B. MEDING, MD  Mooresville, IN
RYAN M. NUNLEY, MD  St. Louis, MO
MARK W. PAGNANO, MD  Rochester, MN

FRIDAY, MAY 12, 2017 | 11:00 AM - 6:00 PM
The William N. Capello, MD Education Center, IU Health Saxony Hospital | 13000 E 136th St, Fishers, IN 46037

Visit www.hipsoc.org and click on the EDUCATION tab to learn more

Call (847) 698-1638 | Email hip@aaos.org
JANUARY 21-24, 2018
Canyons Grand Summit Resort | Park City, Utah

The Hip Society and The Knee Society invite you to join us at JAMM2018 in Park City, Utah, USA, on January 21-24, 2018. JAMM2018 is a unique learning and networking opportunity for orthopaedic surgeons specializing in the adult hip and knee arthroplasty. This highly anticipated and exclusive red-carpet event will be:

- co-chaired by Fred D. Kushner, MD, Aaron A. Hofmann, MD, Adolph V. Lombardi, Jr., MD, and Christopher L. Peters, MD, with a star-studded faculty cast drawn from members of The Hip Society and The Knee Society
- presented during the 2018 Sundance Film Festival
- limited to 100 physician attendees
- enhanced by “The Golden Hip” and “The Golden Knee” video competitions
- a dynamic blend of case-based presentations and small group discussions complemented by didactic lectures
- CME-accredited

SAVE THE DATE!
**Program Highlights**

The Knee Society’s 2017 Scientific Awards (Session IVa, 10:30 am – 11:00 am)

The 2017 John N. Insall, MD Award

*Higher Tissue Concentrations of Vancomycin with Intraosseous Regional Prophylaxis in Revision TKA*

*Presenter:* Simon W. Young, FRACS  
*Co-Authors:* Mei Zhang, PhD; Grant A. Moore, BSc; Rocco P. Pitto; Henry D. Clarke, MD; Mark J. Spangehl, MD

The 2017 Chitranjan S. Ranawat, MD Award

*Does Computer Navigation in Knee Arthroplasty Improve Functional Outcomes in Young Patients?*

*Presenter:* Young-Hoo Kim, MD  
*Co-Authors:* Jang-Won Park, MD; Jun-Shik Kim, MD

The 2017 Mark Coventry, MD Award

*A Randomized Clinical Trial on Patellofemoral vs. Total Knee Replacement for Patellofemoral Osteoarthritis*

*Presenter:* Anders Odgaard, DMed  
*Co-Authors:* Frank Madsen, MD; Per Wagner Kristensen, MD; Andreas Kappel, MD; Jesper Fabrin, MD

Congratulations to all award winners and their co-authors!

The Knee Society’s 2018 Scientific Awards

Manuscripts in consideration for the 2018 Knee Society Scientific Awards may be submitted beginning in September 2017 through *Clinical Orthopaedic and Related Research (CORR)*  

The deadline to submit your best research is December 1, 2017.
The Knee Society’s Research & Education Fund

Promoting outstanding care to patients with knee disorders through innovative research and education

The Knee Society thanks the following Donors for their multi-year pledges of support:

Mentor Level ($250,000 - $499,999)
Dr. & Mrs. Adolph V. Lombardi, Jr.*
Zimmer Biomet, Inc.*

Partner Level ($100,000 - $249,999)
Dr. & Mrs. Keith R. Berend*
Michael E. Berend, MD*
Chitranjan S. Ranawat, MD

Advisor Level ($25,000 - $99,999)
Jeffrey R. McLaughlin, MD*

The Knee Society thanks the following Donors for their generous 2016 contributions:

Visionary Level ($10,000 - $24,999)
John J. Callaghan, MD
Thomas P. Sculco, MD

Leadership Level ($2,500 - $9,999)
Stephen J. Incavo, MD
Robert L. Barrack, MD
Richard Iorio, MD

Loyalty Level ($500 - $2,499)
William L. Healy, MD
Thomas K. Fehring, MD
Mark P. Figgie, MD
Craig J. Della Valle, MD
Michael J. Dunbar, MD

* Contribution given in memory of Dane A. Miller, PhD
BEING BETTER MATTERS

BETTER SELF-ASSESSMENT MEANS BETTER PATIENT CARE

Experience active, stimulating learning – and have the tools you need to better assess your knowledge of current orthopaedic information – with the AAOS special interest self-assessment examinations.

COMING SPRING 2016

NEW! ADULT RECONSTRUCTIVE SURGERY OF THE HIP AND KNEE EXAMINATION

Evaluate your knowledge of primary and revision total hip and total knee replacement. Improve your skills in preventing and managing infection, pain, thromboembolism, and osteolysis. Learn to identify factors contributing to wear of hip and knee bearing surfaces.

- Includes full-length videos of surgical demonstrations.
- Scored and Recorded and Self-Scored formats available

Earn up to **20 CME credits** with 200 multiple-choice questions.

Developed in partnership with:
American Association of Hip and Knee Surgeons,
The Hip Society and The Knee Society

TO ORDER, VISIT aaos.org/self_assess OR CALL 800.626.6726
TRAVELING FELLOWSHIP OPPORTUNITY

John N. Insall Travelling Fellowship
Sponsored by The Knee Society

A group of four international candidates will be selected to travel to various Knee Society locations for this one month program to begin in October 2018.

This annual Fellowship will include visits to internationally recognized joint replacement and knee surgery centers.

Qualifications:

• Applicants must have completed either an Adult Reconstruction Knee Fellowship or Sports Medicine Fellowship.
• Applications must be received by October 1st, 2017.
• The candidates must be able to travel for the month of October the following year.

For Information Contact:
Kathleen E. Lenhardt
Insall Scott Kelly
260 East 66th Street, Ground Floor
New York, NY 10065
(646) 293-7520
klenhardt@iskinstitute.com
www.iskinstitute.com

Congratulations, the 2017 Insall Fellows!

Matthew P. Abdel, MD
Mayo Clinic
Dept. of Orthopedic Surgery
Rochester, Minnesota

Jason Jennings, MD
Colorado Joint Replacement
Denver, Colorado

Umile G. Longo, MD
University Campus Biomedico
of Rome
Rome, Italy

Shinichiro Nakamura, MD
Kyoto University
Dept. of Orthopedic Surgery
Kyoto, Japan
CALL FOR SUBMISSIONS

ABSTRACT SUBMISSIONS
Submit high-quality scientific and socioeconomic abstracts by June 1, 2017 for consideration as podium or poster presentations. Abstracts are blind reviewed by the AAHKS Program Committee review team. If you are interested in serving on the review team, contact meeting@aaahks.org.

SYMPOSIUM PROPOSALS
Submit proposals by June 1, 2017 covering all aspects of arthroplasty and health policy. Proposals are reviewed by the AAHKS Program Committee.

SURGICAL TECHNIQUE VIDEO PROPOSALS
Submit high quality, clinically relevant proposals for videos that will provide high educational value. Selection of videos is based on the overall quality and thoroughness of the proposal submission. The deadline for proposals is June 1, 2017.

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

RESERVE HOTEL ROOM NOW!
You can log in to www.AAHKS.org to make your hotel reservation now at the Hilton Anatole in Dallas. Meeting registration will open in June 2017.
AAHKS
2017 SPRING MEETING
MAY 5 – 6 • SAN FRANCISCO

Do you enjoy the fall meeting but miss the intimate interactions of AAHKS meetings of the past? Are you looking to get your questions answered by leading experts in a small group setting? Then the AAHKS Spring Meeting is for you!

The meeting will be centered around a case-based discussion format in small groups with a maximum of 10 participants per faculty member and symposia on important topics ranging from the business of orthopaedics to perioperative optimization and management. The meeting will facilitate the ideal learning atmosphere for the practicing hip and knee surgeon wanting to learn more about primary and revision hip and knee arthroplasty.

Friday, May 5 – Saturday, May 6, 2017
The Westin St. Francis
San Francisco on Union Square

- Limited attendance
- Instructional Course Lectures (ICL)
- Small group breakouts with faculty

Log in to register for the meeting at www.AAHKS.org
SCHEDULE
**WELCOME**
Harry E. Rubash, MD (Boston, MA) – President, The Hip Society
Kevin J. Bozic, MD, MBA (Austin, TX) – Chair, Education Committee

<table>
<thead>
<tr>
<th>Time</th>
<th>Session I: Minimizing Complications</th>
<th>Speaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 am</td>
<td>Session I: Minimizing Complications</td>
<td>Moderator: Kevin L. Garvin, MD (Omaha, NE)</td>
<td></td>
</tr>
<tr>
<td>8:01 am</td>
<td>The Changing Pattern of Complications After THA</td>
<td>Daniel J. Berry, MD (Rochester, MN)</td>
<td></td>
</tr>
<tr>
<td>8:08 am</td>
<td>Modifying Risk Factors/Preventing Readmissions</td>
<td>Richard Iorio, MD (New Rochelle, NY)</td>
<td></td>
</tr>
<tr>
<td>8:15 am</td>
<td>Avoiding Venous Thromboembolism</td>
<td>Jay R. Lieberman, MD (Los Angeles, CA)</td>
<td></td>
</tr>
<tr>
<td>8:22 am</td>
<td>Preventing Infection</td>
<td>Craig J. Della Valle, MD (Chicago, IL)</td>
<td></td>
</tr>
<tr>
<td>8:28 am</td>
<td>DISCUSSION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:46 am</td>
<td>Session II: Implant Wear: An Update</td>
<td>Moderator: William J. Maloney, III, MD (Redwood City, CA)</td>
<td></td>
</tr>
<tr>
<td>8:46 am</td>
<td>Long-term Results with Polythene</td>
<td>James I. Huddleston, III, MD (Redwood City, CA)</td>
<td></td>
</tr>
<tr>
<td>8:53 am</td>
<td>Update on Ceramics</td>
<td>Adolph V. Lombardi, Jr., MD, FACS (New Albany, OH)</td>
<td></td>
</tr>
<tr>
<td>9:00 am</td>
<td>Are There Indications for Metal-on-Metal THA and Resurfacing?</td>
<td>Robert L Barrack, MD (St. Louis, MO)</td>
<td></td>
</tr>
<tr>
<td>9:07 am</td>
<td>Future Bearing Surfaces: What to Look For!</td>
<td>Orhun K. Muratoglu, PhD (Boston, MA)</td>
<td></td>
</tr>
<tr>
<td>9:13 am</td>
<td>DISCUSSION</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Marriott Grand Ballroom 8

### 7:55 am – 8:00 am

**WELCOME**
Thomas P. Sculco, MD (New York, NY) – President of The Knee Society  
Stephen J. Incavo, MD (Houston, TX) – Chair, Education Committee

### 8:00 am – 8:45 am

**Session I: The Difficult Primary TKA – 1**  
**Moderator: Arlen D. Hanssen, MD (Rochester, MN)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:01 am – 8:07 am</td>
<td>Management of Stiff Knee</td>
<td>Steven J. MacDonald, MD (London, ON, Canada)</td>
<td>25</td>
</tr>
<tr>
<td>8:08 am – 8:14 am</td>
<td>Flexion Contracture</td>
<td>Adolph V. Lombardi, Jr., MD, FACS (New Albany, OH)</td>
<td>29</td>
</tr>
<tr>
<td>8:15 am – 8:21 am</td>
<td>The Valgus Knee: Is It More Difficult?</td>
<td>Paul F. Lachiewicz, MD (Chapel Hill, NC)</td>
<td>31</td>
</tr>
<tr>
<td>8:22 am – 8:28 am</td>
<td>Previous Incisions: What to Do?</td>
<td>John J. Callaghan, MD (Iowa City, IA)</td>
<td>32</td>
</tr>
<tr>
<td>8:28 am – 8:45 am</td>
<td>DISCUSSION</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 8:45 am – 9:30 am

**Session II: The Difficult Primary TKA – 2**  
**Moderator: Douglas A. Dennis (Denver, CO)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:46 am – 8:52 am</td>
<td>Extra-Articular Deformity</td>
<td>Stephen J. Incavo, MD (Houston, TX)</td>
<td>33</td>
</tr>
<tr>
<td>8:53 am – 8:59 am</td>
<td>Previous ACL or Osteotomy Surgery</td>
<td>David Backstein, MD, FRCS(C) Toronto, ON, Canada</td>
<td>35</td>
</tr>
<tr>
<td>9:00 am – 9:06 am</td>
<td>Prior Infection</td>
<td>Arlen D. Hanssen, MD (Rochester, MN)</td>
<td>38</td>
</tr>
<tr>
<td>9:07 am – 9:13 am</td>
<td>Is Constraint Needed in Primary TKA?</td>
<td>Mark P. Figgie, MD (New York, NY)</td>
<td>40</td>
</tr>
<tr>
<td>9:13 am – 9:30 am</td>
<td>DISCUSSION</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Marriott Grand Ballroom 5

<table>
<thead>
<tr>
<th>Time</th>
<th>Session III: Taper Corrosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:30 am – 10:15 am</td>
<td>Moderator: Wayne G. Paprosky, MD, FACS (Winfield, IL)</td>
</tr>
</tbody>
</table>
| 9:31 am – 9:37 am | State-of-the-Art in Understanding This Issue  
Joshua J. Jacobs, MD (Chicago, IL) |
| 9:38 am – 9:44 am | Clinical Presentation/Diagnosis  
Michael A. Mont, MD (Cleveland, OH) |
| 9:45 am – 9:51 am | Fretting and Corrosion at the Head-Neck Junction of Well-Functioning THAs  
Douglas E. Padgett, MD (New York, NY) |
| 9:52 am – 9:58 am | Optimizing Clinical Treatment and Outcomes  
Young-Min Kwon, MD, PhD, FRACS, FRCS (Boston, MA) |
| 9:58 am – 10:15 am | DISCUSSION                                                                 |
| 10:15 am – 10:30 am | COFFEE/REFRESHMENT BREAK                                                                  |

<table>
<thead>
<tr>
<th>Time</th>
<th>Session IV: Prevention/Management Geriatric Hip</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 am – 11:25 am</td>
<td>Moderator: Harry E. Rubash, MD (Boston, MA)</td>
</tr>
</tbody>
</table>
| 10:31 am – 10:37 am | Prevention of Geriatric Hip Fractures  
Joseph M. Lane, MD (New York, NY) |
| 10:38 am – 10:44 am | Developing and Implementing a Comprehensive Hip Fracture Program  
Stephen L. Kates, MD (Richmond, VA) |
| 10:45 am – 10:51 am | Fix or Replace? Results from “Big Data”  
George J. Haidukewych, MD (Orlando, FL) |
| 10:52 am – 10:57 am | Introduction of Presidential Guest Speaker  
Harry E. Rubash, MD (Boston, MA) |
| 10:58 am – 11:13 am | Presidential Guest Speaker: Outcomes of Comprehensive Hip Fracture Mgmt Programs: An International Perspective  
Cecilia Rogmark, MD, PhD (Lund, Sweden) |
<p>| 11:14 am – 11:25 am | DISCUSSION                                                                 |</p>
<table>
<thead>
<tr>
<th>Time</th>
<th>Session III: Current Trends in Arthroplasty</th>
</tr>
</thead>
</table>
| 9:31 am – 9:37 am | Current Joint Restoration Procedures  
Patrick C. McCulloch, MD (Houston, TX) |
| 9:38 am – 9:44 am | Unicompartmental Arthroplasty in 2017  
Craig J. Della Valle, MD (Chicago, IL) |
| 9:45 am – 9:51 am | ACL/PCL Design: What the Future Holds  
Christopher L. Peters, MD (Salt Lake City, UT) |
| 9:52 am – 9:58 am | Medial Pivot Design  
C. Lowry Barnes, MD (Little Rock, AR) |
| 9:58 am – 10:15 am | DISCUSSION |

11:00 am – 11:15 am Session IVb: Highlights

11:01 am – 11:08 am AAHKS 2016 Annual Meeting  
William A. Jiranek, MD (Richmond, VA)

11:09 am – 11:15 am The John N. Insall, MD Traveling Fellowship  
W. Norman Scott, MD (New York, NY)
### Session V: Transitioning to Outpatient THA: Point/Counterpoint

**Moderator:** Steven J. MacDonald, MD, FRCSC (London, ON, Canada)

#### 11:25 am – 11:32 am
**Building an Outpatient THA Program**
*R. Michael Meneghini, MD (Fishers, IN)*

#### 11:33 am – 11:40 am
**Outpatient THA is a Triumph of Passion Over Reason**
*Vincent D. Pellegrini, Jr., MD (Charleston, SC)*

#### 11:41 am – 12:00 pm
**DISCUSSION**

#### Lunch

**LUNCH – Box lunches provided to all participants**

### Session VIa: The Hip Society’s Scientific Awards

**Moderators:** Paul E. Beaulé, MD, FRCSC (Ottawa, ON, Canada) & C. Anderson Engh, Jr., MD (Alexandria, VA)

#### 1:01 pm – 1:02 pm
**Introduction:** The John Charnley Award

#### 1:02 pm – 1:08 pm
*A Randomized Clinical Trial of Direct Anterior Approach and Mini-Posterior Approach Total Hip Arthroplasty*

*Michael J. Taunton, MD (Rochester, MN)*

#### 1:08 pm – 1:09 pm
**Award Presentation**

#### 1:10 pm – 1:11 pm
**Introduction:** The Otto Aufranc Award

#### 1:11 pm – 1:17 pm
*A Prospective, Randomized Study of Crosslinked and Non-crosslinked Poly for Total Hip Arthroplasty at 15-Year Followup*

*Robert H. Hopper, Jr., PhD (Alexandria, VA)*

#### 1:17 pm – 1:18 pm
**Award Presentation**

#### 1:18 pm – 1:24 pm
“Dual-Mobility Constructs in Revision THA Reduced Dislocation, Re-Revision & Reoperation Compared to Large Femoral Heads”

*Matthew P. Abdel, MD (Rochester, MN)*

#### 1:24 pm – 1:25 pm
**Award Presentation**

#### 1:26 pm – 1:27 pm
**Introduction:** The Frank Stinchfield Award

#### 1:27 pm – 1:33 pm
*Identification of the ‘At Risk’ Genotype for Development of Pseudotumours around Metal-on-Metal Total Hip Arthroplasties*

*Andrew P. Kurmis, FRACS, MBBS, PhD (Vancouver, BC, Canada)*

#### 1:33 pm – 1:34 pm
**Award Presentation**
<table>
<thead>
<tr>
<th>Time</th>
<th>Session V: “Lessons Learned” from Difficult Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:15 am – 12:00 pm</td>
<td>Moderator: Robert T. Trousdale, MD (Rochester, MN)</td>
</tr>
<tr>
<td></td>
<td>ARS in use</td>
</tr>
</tbody>
</table>

11:16 am – 11:21 am  
Case 1

11:22 am – 11:27 am  
Case 2

11:28 am – 11:33 am  
Case 3

11:34 am – 11:39 am  
Case 4

11:40 am – 11:55 am  
Panel Discussion  
Kevin L. Garvin, MD (Omaha, NE); William L. Griffin, MD (Charlotte, NC); Douglas D.R. Naudie, MD (London, ON, Canada); Carlos J. Lavernia, MD (South Miami, FL)

11:55 am – 12:00 pm  
Audience Votes

<table>
<thead>
<tr>
<th>Time</th>
<th>Session VI: Perioperative Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00 pm – 1:45 pm</td>
<td>Moderator: Daniel J. Berry, MD (Rochester, MN)</td>
</tr>
<tr>
<td></td>
<td>ARS in use</td>
</tr>
</tbody>
</table>

1:01 pm – 1:07 pm  
Pain Control  
Mark W. Pagnano, MD (Rochester, MN)

1:08 pm – 1:14 pm  
Post-Op Rehab/Physical Therapy  
Matthew S. Austin, MD (Philadelphia, PA)

1:15 pm – 1:21 pm  
Anticoagulation and Bleeding: Where Are We in 2017?  
Javad Parvizi, MD (Philadelphia, PA)

1:22 pm – 1:28 pm  
Bilateral TKA: How To Do It Safely  
Thomas P. Sculco, MD (New York, NY)

1:29 pm – 1:45 pm  
DISCUSSION
# Session VIb: The Hip Society's Fellowships

**Moderator:** Chitranjan S. Ranawat, MD (New York, NY)

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:35 pm – 1:36 pm</td>
<td>Introduction of the Hip Society Fellowships</td>
<td>Chitranjan S. Ranawat, MD (New York, NY)</td>
</tr>
<tr>
<td>1:36 pm – 1:40 pm</td>
<td>Highlights of the 2016 Hip Society – British Hip Society Traveling Fellowship</td>
<td>Michael Blankstein, MSc, MD, FRCS(C) (South Burlington, VT) &amp; Joseph M. Schwab, MD, (Milwaukee, WI)</td>
</tr>
<tr>
<td>1:40 pm – 1:44 pm</td>
<td>Recap of the 2016 Rothman-Ranawat Fellowship</td>
<td>Atul F. Kamath, MD (Philadelphia, PA)</td>
</tr>
<tr>
<td>1:44 pm – 1:45 pm</td>
<td>Introduction of the 2017 Hip Society Rothman-Ranawat Traveling Fellows</td>
<td>Chitranjan S. Ranawat, MD (New York, NY)</td>
</tr>
</tbody>
</table>

# Session VII: “Lessons Learned” from Difficult Cases

**Moderator:** Thomas P. Schmalzried, MD (Los Angeles, LA)

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:46 pm – 1:51 pm</td>
<td>Case 1</td>
<td></td>
</tr>
<tr>
<td>1:52 pm – 1:57 pm</td>
<td>Case 2</td>
<td></td>
</tr>
<tr>
<td>1:58 pm – 2:03 pm</td>
<td>Case 3</td>
<td></td>
</tr>
<tr>
<td>2:04 pm – 2:09 pm</td>
<td>Case 4</td>
<td></td>
</tr>
<tr>
<td>2:10 pm – 2:23 pm</td>
<td>Panel Discussion</td>
<td>Michael E. Berend, MD (Indianapolis, IN); John J. Callaghan, MD (Iowa City, IA); Scott M. Sporer, MD, MS (Winfield, IL); Wayne G. Paprosky, MD, FACS (Winfield, IL)</td>
</tr>
<tr>
<td>2:23 pm – 2:30 pm</td>
<td>Audience Votes</td>
<td></td>
</tr>
<tr>
<td>2:30 pm – 2:45 pm</td>
<td>COFFEE/REFRESHMENT BREAK</td>
<td></td>
</tr>
</tbody>
</table>
# Session VII: Instability in TKA: Causes and Prevention

**Moderator:** Robert L. Barrack, MD (St. Louis, MO)

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:46 pm</td>
<td>AP and ML Instability</td>
<td>David G. Lewallen, MD (Rochester, MN)</td>
<td>57</td>
</tr>
<tr>
<td>1:53 pm</td>
<td>Patella Instability</td>
<td>Giles R. Scuderi, MD (New York, NY)</td>
<td>59</td>
</tr>
<tr>
<td>2:00 pm</td>
<td>Extensor Mechanism Failure</td>
<td>Rafael J. Sierra, MD (Rochester, MN)</td>
<td>60</td>
</tr>
<tr>
<td>2:07 pm</td>
<td>The Unstable Revision TKA</td>
<td>Michael D. Ries, MD (Carson City, NV)</td>
<td>61</td>
</tr>
<tr>
<td>2:14 pm</td>
<td>DISCUSSION</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DISCUSSION**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker</th>
<th>Page</th>
</tr>
</thead>
</table>

## Session VIII: Patient Satisfaction

**Moderator:** William J. Griffin, MD (Charlotte, NC)

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:46 pm</td>
<td>Is It Expectation?</td>
<td>Matthew J. Kraay, MD (Cleveland, OH)</td>
<td>62</td>
</tr>
<tr>
<td>2:53 pm</td>
<td>How Do We Measure It?</td>
<td>Philip C. Noble, PhD (Houston, TX)</td>
<td>64</td>
</tr>
<tr>
<td>3:00 pm</td>
<td>Can We Identify a Poor Surgical Candidate?</td>
<td>David C. Ayers, MD (Worcester, MA)</td>
<td>66</td>
</tr>
<tr>
<td>3:07 pm</td>
<td>What To Do About It?</td>
<td>Jay R. Lieberman, MD (Los Angeles, CA)</td>
<td>69</td>
</tr>
<tr>
<td>3:14 pm</td>
<td>DISCUSSION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Session Title</td>
<td>Speaker</td>
<td>Location</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------------------------------------</td>
<td>--------------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>2:45 pm – 3:30 pm</td>
<td><strong>Session VIII: Surgical Approaches to the Hip</strong>&lt;br&gt;Moderator: Daniel J. Berry, MD (Rochester, MN)</td>
<td>ARS in use</td>
<td>Marriott Grand Ballroom 5</td>
</tr>
<tr>
<td>2:53 pm – 2:59 pm</td>
<td>Posterior Approach: Still the “Gold Standard”?</td>
<td>Mark W. Pagnano, MD (New Albany, OH)</td>
<td>65</td>
</tr>
<tr>
<td>3:00 pm – 3:06 pm</td>
<td>Is Surgical Approach a Risk Factor for Early Failure of Primary THA?</td>
<td>Bryan D. Springer, MD (Charlotte, NC)</td>
<td>66</td>
</tr>
<tr>
<td>3:07 pm – 3:30 pm</td>
<td>DISCUSSION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:30 pm – 4:15 pm</td>
<td><strong>Session IX: Instability</strong>&lt;br&gt;Moderator: David G. Lewallen, MD (Rochester, MN)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:38 pm – 3:44 pm</td>
<td>The Solution: Large Diameter Femoral Heads</td>
<td>Thomas P. Vail, MD (San Francisco, CA)</td>
<td>69</td>
</tr>
<tr>
<td>3:45 pm – 3:51 pm</td>
<td>The Solution: Dual Mobility Cups</td>
<td>Arlen D. Hanssen, MD (Rochester, MN)</td>
<td>70</td>
</tr>
<tr>
<td>3:52 pm – 3:58 pm</td>
<td>The Solution: Constrained Acetabular Components</td>
<td>Thomas P. Sculco, MD (New York, NY)</td>
<td>71</td>
</tr>
<tr>
<td>3:59 pm – 4:15 pm</td>
<td>DISCUSSION</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Session X: Transitioning to Value-Based Healthcare is a COMBINED SESSION with The Knee Society and will be held in Grand Ballroom 8.**
Session IX: Complications
Moderator: William L. Healy, MD (Newton, MA)

3:30 pm – 4:15 pm

3:30 pm – 3:45 pm
Optimizing Risk Factors and Preventing Readmissions
Richard Iorio, MD (New Rochelle, NY)

3:36 pm – 3:51 pm
Infection Prevention: What Should We Do?
Bryan D. Springer, MD (Charlotte, NC)

3:42 pm – 3:58 pm
When is Irrigation and Debridement Indicated for Infection?
David J. Mayman, MD (New York, NY)

3:54 pm – 4:10 pm
Two Stage vs. One-Stage Treatment of Deep Infection in 2017
Fares S. Haddad, MD (London, United Kingdom)

3:59 pm – 4:15 pm
DISCUSSION

COMBINED SESSION X: Transitioning to Value-Based Healthcare
Moderators Kevin J. Bozic, MD, MBA (Austin, TX) & Richard Iorio, MD (New Rochelle, NY)

4:15 pm – 5:15 pm

4:15 pm – 4:30 pm
Optimizing Patient Health Status and Improving Outcome for TJA: Using Population Health Management to Deliver Value-Based Care
Joseph A. Bosco, III, MD (New York, NY)

4:21 pm – 4:37 pm
Partnering with the Patient to Improve Outcomes in the TJA: The Role of Shared-Decision Making in Advising Patients of Risk and Comorbidity Burdens
Kevin J. Bozic, MD, MBA (Austin, TX)

4:32 pm – 4:48 pm
Value-Based Payment Strategies, MACRA, and the Merit-Based Incentive Payment Program: Advanced Alternative Payment Models Are Our Best Way Forward
Shari M. Ling, MD, Deputy Chief Medical Officer, Centers for Medicare and Medicaid Services (Brooklyn, MD)

4:54 pm – 5:10 pm
The Role of Registries, PROs, and Quality Measures in Improving Value and Outcomes and Determining Physician’s Payment: This is Our Future!
David C. Ayers, MD (Worcester, MA)

4:59 pm – 5:15 pm
DISCUSSION

5:15 pm
MEETING ADJOURNED
Harry E. Rubash, MD (Boston, MA) & Thomas P. Sculco, MD (New York, NY)
ABSTRACTS
Background
Achieving maximum flexion and extension is a key goal in total knee arthroplasty (TKA) surgery. It should be emphasized from the beginning however that preoperative motion is a significant determinant of postoperative motion, so realistic goals must be set by both the patient and the surgeon.

It also needs to be stated that maximal range of motion cannot be achieved with a TKA unless proper knee alignment and balancing is performed. While it is beyond the scope of this talk, there are certain common balancing scenarios that need to be understood and addressed to achieve maximal flexion and extension.

Ligament Balancing

There are various approaches to ligament balancing, and suggested orders of release from different authors. Regardless of the specific technique, the overall goals remain the same. The flexion gap should equal the extension gap. Within each gap, the medial and lateral sides of the gap should be equal.

It is this author’s preferred technique to perform all bony cuts first, remove all osteophytes, and only at that point assess the flexion and extension gaps with spacer blocks.

There are specific scenarios that are then seen clinically:

A: The Varus Knee

Tight Medially In Flexion

This is seen occasionally in the varus knee. This is addressed by releasing only the anterior portion of the medial collateral ligament. This can be done with a spacer block in place, and done very slowly under direct vision. Over-release needs to be avoided as this will lead to flexion instability. It is common though that once this release is performed, the polyethylene trial may have to be upsized one size.

Tight Medially In Extension

This is seen more commonly in the varus knee. In this scenario, it is the posterior structures that should be released, coming right around the posterior-medial corner of the tibia. Commonly there may be osteophytes that have been missed that should be resected.

B: The Valgus Knee

Traditional teaching espoused the principle of fully releasing specific structures. Most authors now prefer a more limited release of the structures that are tight. This has been described as a pie-crusting technique.

Following bone cuts the knee is brought into extension and either a spacer block, or a laminar spreader is placed in the extension gap. The lateral sided structures are palpated to determine the tightest structures.
Using a #15 blade, the posterolateral capsule and arcuate ligament complex can be incised at the level of the joint line in the short interval between the fibular collateral ligament and the popliteus. The blade is then used to make multiple stab incisions in the tightest structures remaining on the lateral side, normally the iliotibial band and fibular collateral ligament. The spacer blocks or laminar spreader is placed frequently as releases are done, to titrate the releases. Popliteus can be released if there is significant tightness in the flexion gap on the lateral side only.

**C: All Knees**

Additionally there are scenarios that the surgeon will see regardless of preoperative deformity:

*Both flexion and extension gaps are tight but equal*

This is best managed normally with further tibial resection

*Tight extension gap only*

This is commonly seen with a preexistent fixed flexion contracture. It is important to not simply resect further distal femur in these cases. The surgeon must look specifically for posterior femoral osteophytes and remove them. Tight posterior capsule should be released. Most of the deformity can be corrected with soft tissue release. Resecting an additional 1-2mm of distal femur may be necessary, but excessive bone resection can lead to instability, particularly mid-flexion instability, which is very difficult to address.

Another common error in this scenario is to downsize the polyethylene to balance the extension gap, but leaving the flexion gap loose. This results also in instability and should be avoided. Patients do not tolerate well a flexion gap with excessive laxity.

*Tight flexion gap only*

In this scenario the surgeon must first check the tibial resection, ensuring that there has not been an inadvertent reverse slope cut. If the flexion gap is significantly tighter than the extension gap, then the femoral component may have been oversized, leading to an overstuffing of the flexion gap. Downsizing of the femoral component will then increase the flexion gap, resulting in a balanced knee. It should be emphasized that downsizing of the femoral component should only rarely be necessary, and that if this is done inappropriately, flexion gap instability can occur.

**Intraoperatively the TKA does not bend**

The arthroplasty surgeon must be aware of the common scenarios that lead to the potential for a knee that is limited in its flexion and be prepared to deal with them:

1) **Issues of Gap Balancing and Component Sizing**
   - discussed in detail above. This is by far the most common cause of a tight flexion gap, or in other words a TKA that does not bend well

2) **Posterior osteophytes**
   - failure to resect large posterior femoral osteophytes can limit both flexion and terminal extension. Removal of these posterior osteophytes is a critical step in most TKA procedures.

3) **Overstuffing of the Patella**
   - if the patella thickness is increased significantly then there is the potential to loose flexion. For every 2mm the patella thickness is increased, one can see the loss of 3 degrees of flexion
4) Anterior translation of the femoral component
   – if the femoral component is allowed to translate too far anteriorly, this can overstuff the extensor mechanism and lead to pain and decreased flexion. For every 1mm of excessive anterior femoral translation, one can see the loss of 2 degrees of flexion

5) Tibial slope
   - as discussed above, if there is insufficient or reversed tibial slope, this can result in limited intraoperative flexion

**Intraoperatively the TKA does not straighten out**

For the purpose of this discussion, it is assumed that the surgeon is happy with the flexion gap, but that the extension gap is too tight, preventing the TKA from coming out straight. The surgeon should then look for these scenarios:

1) Posterior femoral osteophytes
   - the inadvertent retention of posterior femoral osteophytes will act as a posterior tether and will prevent the knee from fully extending. Posterior osteophytes should always be resected with an osteotome

2) Tight posterior capsule
   - this is seen when a knee has a significant preoperative fixed flexion contracture. An excessively tight posterior capsule can limit terminal knee extension. This can be released safely from the posterior surface of the distal femur with a cautery and then a cob elevator.

3) The last step would be to resect further distal femur. Often simply resecting an additional 2mm of distal femur, thereby creating a larger extension gap, will allow the knee to come into full extension. Again caution should be used in that excessive distal femoral resection and elevation of the joint line, can result in med-flexion instability
References

Ritter MA, Harty LD, Davis KE, Meding JB, Berend ME
Predicting range of motion after total knee arthroplasty. Clustering, log-linear regression, and regression tree analysis

Yau WP, Chiu KY, Tang WM, Ng TP
Residual posterior femoral condyle osteophyte affects the flexion angle after total knee replacement
Int Orthop, Dec 29(6):375-9, 2005

Bengs BC, Scott RD
The effect of patellar thickness on intraoperative knee flexion and patellar tracking in total knee arthroplasty

Mihalko W, Fishkin Z, Krackow K
Patellofemoral overstuff and its relationship to flexion after total knee arthroplasty

Bellemans J, Robijns F, Duerinckx J, Banks S, Vandenneucker H
The influence of tibial slope on maximal flexion after total knee arthroplasty
The etiology of the flexion contracture is related to recurrent effusions present in a knee with end-stage degenerative joint disease secondary to the associated inflammatory process. These recurrent effusions cause increased pressure in the knee causing pain and discomfort. Patients will always seek a position of comfort, which is slight flexion. Flexion decreases the painful stimulus by reducing pressure in the knee and relaxing the posterior capsule. Unfortunately, this self-perpetuating process leads to a greater degree of contracture as the disease progresses. Furthermore, patients rarely maintain the knee in full extension. Even during the gait cycle the knee is slightly flexed. As their disease progresses, patients limit their ambulation and are more frequently in a seated position. Patients often report sleeping with a pillow under their knee or in the fetal position. All of these activities increase flexion contracture deformity. Patients with excessive deformity >40° should be counseled regarding procedural complexity and that increasing constraint may be required. Patients are seen preoperatively by a physical therapist and given a prearthroplasty conditioning program. Patients with excessive flexion contracture are specifically instructed on stretching techniques, as well as quadriceps rehabilitation exercises.

**Surgical Technique:**

Femoral nerve blocks are discouraged, because their use necessitates ambulation with an immobilizer and is counter to the need of the flexion contracture patient to have a well-functioning extensor mechanism. Prior to skin incision the surgeon should make a critical evaluation of the degree of deformity present and ability to correct the deformity. Can the varus or valgus malalignment be corrected to neutral? What is the status of the medial and lateral collateral ligaments? When holding the extremity by the heel and raising the leg, is there a flexion contracture? Does the knee come to full extension? The patient with a fixed varus deformity and associated flexion contracture can be addressed immediately with an extensive soft tissue release from the proximal medial tibia to include the deep medial collateral, meniscal capsular ligament, semimembranosus, and perhaps some of the superficial medial collateral, whereas in the patient with a fixed valgus deformity, medial exposure should not go beyond the mid-coronal plane. Osteophytes on the distal femur and proximal tibia are removed. The goals of tibial resection are similar to femoral resection - that is to re-establish the tibial joint line. In flexion contractures the flexion gap is generally greater than the extension gap and, therefore, a resection without posterior slope will facilitate balance of the flexion/extension gap. Upon completion of tibial resection, attention should be turned to completion of distal femoral preparation. To facilitate balance of the knee with flexion contracture, the largest size possible is chosen. Upon completion of femoral resections the most important part of the procedure ensues - removal of posterior osteophytes and re-establishment of the posterior recess of the knee by release of the posterior capsule accomplished by subperiosteal stripping of the capsule with a curved osteotome. Trial tibial and femoral components or spacer blocks are now placed and the appropriate polyethylene inserted to balance the flexion/extension gaps and collateral ligaments. Fine adjustment of varus and valgus structures is done and gap balance assessed. If there is continued flexion contracture and all releases have been accomplished then further distal femoral resection will be required to balance the gaps and obtain full extension. If an additional 2mm of distal femoral resection does not accomplish full extension, converting to a posterior stabilized arthroplasty and removing additional distal femur is advised. In cases of severe flexion contracture where greater amounts of distal femoral resection are required to obtain full extension, all structures anterior to the posterior capsule are somewhat lax in full extension and a posterior stabilized constrained device may be required for varus/valgus stabilization through the entire arc of motion. Wound closure follows standard techniques with the exception that patients who have a severe flexion contracture (>30°) may require a proximal realignment of the extensor.
mechanism, that is a lateral and distal advancement of the vastus medialis obliquus in an effort to strengthen the extensor mechanism and place the quadriceps at a mechanical advantage.

**Postoperative Regime:**
The focus in the postoperative physiotherapy rehabilitation program continues toward the goal of full extension. Patients are instructed in appropriate stretching regimes. Patients are immobilized for the first 24 hours in full extension with plaster splints, such as with a modified Robert Jones dressing. This dressing is removed on postoperative day one. The patient is then placed in a knee immobilizer and instructed to wear it at bed rest, during ambulation and in the evening, only removing for ROM exercises. In cases of severe flexion deformity >30°, patients are maintained in full extension for 3-4 weeks until ROM is begun. Patients are encouraged to use a knee immobilizer for at least the first 6 weeks postoperatively.

**Avoiding Pitfalls and Complications:**
Treating patients with flexion involves a combination of bone resection and soft tissue balance. One must make every effort to preserve both the femoral and tibial joint line. In flexion contracture the common error is to begin by resecting additional distal femur, which may result in joint line elevation and mid-flexion instability. The distal femoral resection should remove that amount of bone being replaced with metal. Attention should be directed at careful and meticulous balance of the soft tissues and release of the contracted posterior capsule with re-establishment of the posterior recess, which will correct the majority of flexion contractures.

**Suggested Reading:**
An excessive valgus deformity is seen in 9 to 23% of arthritic knees, with the frequency dependent on the precise definition and practice referral patterns. The pathoanatomy includes hypoplasia of the lateral femoral condyle, loss of articular cartilage, synovitis-effusion, and stretch of the medial ligamentous structures. In more advanced deformities, there is erosion of bone in the tibia and lateral femur, contracture of the posterolateral ligament complex, and eventual incompetence of the medial collateral ligament.

Lateral collateral ligament release for fixed valgus deformity was described by Insall, Scott, and Ranawat for correcting deformity with the total condylar knee prosthesis. This involved transverse division of the iliotibial band and sharp release of the lateral collateral ligament–popliteus from the epicondyle, with further posterolateral releases if necessary. However, this technique risked late devascularization of the femur and component failure. The current preferred lateral ligament release involves “pie-crusting” of the iliotibial band and contracted posterolateral capsule. The medial collateral ligament is then tensioned by a thicker polyethylene spacer. The author recommends pre-operative templating, and the use of Whitesides lines or the epicondylar axis for femoral component positioning. Spacer bar is used in extension and flexion to determine the adequacy of lateral release and the MCL before the trial components are placed. In the author’s series of 123 knees with a preoperative valgus deformity, pie crusting alone balanced the knee in 66%. At mean 7 year follow-up, there were three mechanical failures: one MCL rupture, one medial condyle fracture, and one femoral loosening. However, there are certain patients in whom the medial collateral ligament cannot be tensioned satisfactorily or there is danger of restretch, and there are several proposed strategies for this scenario, including MCL advancement, rotating hinge, and varus-valgus constrained (CCK) components. In the author’s series of 36 CCK knees, usually implanted with stem extensions, in patients with MCL incompetence, there were no mechanical failures at a mean follow-up of 6 years.

Arthritic knees with valgus deformities are more challenging because they are not as frequent as varus deformities, and usually require different techniques for component positioning and releases. However, both the “pie-crusting” lateral release technique and CCK components are successful.
Studies evaluating the perfusion to the anterior knee including transcutaneous oxygen tension measurements of the skin after knee incisions have all demonstrated compromised oxygenation to the lateral skin flap. The blood supply originating from the medial side is better than the lateral side. Thus a medial knee incision will result in a larger lateral area with potential for compromised circulation. It is because of this, one should consider using a previous lateral knee incision when both a lateral and medial incision are present. A second important concept is an understanding of the vascular supply to the subcutaneous tissue of the anterior knee. The deep fascial vascular network sends vessels that penetrate the subcutaneous fat to reach the epidermis. There is little communication between vessels at the superficial level. Therefore, wide dissection superficial to the deep fascia will compromise the blood supply to the skin, whereas dissection deep to the fascia will maintain the skin blood supply. This is why there is a need for elevation of full thickness skin flaps during knee dissection.

In practice, we use previous lateral knee incisions that have been used for trauma or reconstruction around the knee. Old lateral oblique incisions are not a concern. With multiple previous incisions, we use the most lateral incision, unless there has been recently successful use of a medial incision without complications. If there are multiple incisions with marked scarring of the skin and subcutaneous tissue, we consider gastrocnemius flaps and tissue expanders.
Total knee arthroplasty (TKA) in the presence of extra-articular deformity is a challenging endeavor, yet the goal remains constant; a well aligned, stable TKA. To achieve satisfactory alignment and stability the surgeon must identify the coronal (medial-lateral), sagittal (anterior-posterior), and/or rotational deformity. How to achieve these goals requires consideration of multiple factors, including the degree and location of the deformity, as well as the patient’s age and functional level.

Treatment options include: intra-articular correction (one stage), simultaneous corrective extra-articular osteotomy and TKA, or two stage corrective osteotomy followed by TKA at a later date. The knee replacement literature is very limited with no method demonstrating superiority.

Intra-articular correction with ligament release and angled bone cuts are limited by the integrity of the collateral ligaments. As a starting point, bone resection of greater than or equal to 15 mm may lead to ligament imbalance. When the correction requires bone resection of this degree a corrective osteotomy or a more constrained TKA design should be considered.

Extra-articular correction is most common on the femoral side, often due to mal-united femoral fractures. Once the corrective osteotomy is calculated and cut, fixation of the osteotomy can be achieved by an intramedullary (IM) rod, plates and screws, or just by bone apposition to be stabilized by a stemmed femoral component. The distal femoral cut can then be guided by the IM rod, extramedullary alignment, or computer assistance. Importantly, the femoral osteotomy fixation must provide for a stable osteotomy. Recovery after a combined procedure will likely be longer than a routine primary knee arthroplasty, since healing of the osteotomy is critical.

Two stage osteotomy / TKA is best considered in several situations: 1.) The corrective osteotomy may delay the need for TKA; 2.) The younger, active patient expecting a “routine” recovery; and 3.) Rotational osteotomies of the femur which may require diaphyseal osteotomy and longer healing times. When fixation is used, a plan to remove the fixation at the subsequent knee arthroplasty is important.
References


Two common sources of complexity in TKA surgery is a history of prior ACL injury and prior peri-articular osteotomy.

**TKA with History of ACL Deficiency / Reconstruction**

- Patients with ACL deficient knees have altered gait mechanics (Herman, 2016)
- ACL injury in early adulthood leads to a greater lifetime risk of early knee OA and TKA (Suter, 2016)
- Even greater risk if associated with meniscal injury
- Issues (Berend, 2016):
  - greater coronal deformity
  - lower pre-operative ROM
  - greater chondral damage
  - greater osteophyte formation
- Be prepared to deal with prior scars. There are often several scars.
  a. Mark all scars
  b. Avoid small skin bridges

- Coronal deformity is due to extensive medial wear leading to varus deformity.
  a. Make a conservative cut of the medial tibia and be careful to avoid removing excessive bone laterally
  b. Remove medial osteophytes completely
  c. Be prepared to perform medial release or even reduction of medial tibial plateau to gain correction and make gaps acceptable

- Beware of potential post operative stiffness.
  a. Remove obviously scarred tissue
  b. Completely excise ACL graft tissue
  c. Err on the side of loose rather than tight TKA

**TKA with History of Osteotomy**

- Osteotomies can either be distal femoral (DFVO) or proximal tibia (HTO)
- HTO can be lateral-closing-wedge or medial-opening wedge

**DFVO**

- Not as technically challenging as post-HTO TKA
- Issues:
  1. Prior incision - Usually DFVO is performed through midline or far lateral incision so wound problems less prevalent
     - Midline incision can be used for TKA
  2. Patella baja - not usually a problem
  3. Hardware removal – either medial blade or lateral locking plate
     - Can usually remove either plate through midline incision
• Consider use of navigation and retain plate but this is not usually possible and be prepared to bypass screw holes with a stem or plan for non-weight bearing period

4. DFVO produces an extra articular varus deformity
   • Plan reduced thickness of distal medial femoral cut

5. Soft tissue balance issues
   • Will have combination of valgus features and post-surgical varus features

**HTO**
• Conflicting reports about outcomes in the literature
• Recent paper reveals no difference in TKA survivorship when compared to TKA without prior HTO (Badawy, 2015) contradicted by Robertsson et al (2015) which found increased risk of revision
• Also may be no difference in functional outcomes when osteotomy was proximal tibial opening wedge (Saragaglia, 2016)
• Patients tend to be:
  ✓ younger
  ✓ larger
  ✓ active

• Issues:
  1. Previous scar
     • Previous transverse incision is common with lateral closing wedge
     • Medial opening wedge scars are usually midline and not an issue
     • Cross transverse incision at right angle
     • Avoid small skin bridge
     • Use most lateral incision possible

  2. Hardware Removal
     • I tend to remove it
     • May be left in place if not interfering with component placement
     • Beware of forced malposition

  3. Patella baja: exposure, tracking
     • Be careful not to avulse the tendon
     • Consider lateralizing patella rather than everting

  4. Periarticular scarring

  5. Preoperative malalignment (due to over/under correction)
     • Lateral closing wedge technique causes bone loss laterally
     • For TKA, remove less bone laterally when cutting tibia to re-establish pre-osteotomy level
     • 2-3mm lateral instead of usual 8-10mm
     • Will still need thicker than usual polyethylene to balance lax medial side caused by earlier valgus malalignment

  6. Proximal tibial bone deficiency & extra articular deformity
     • Consider use of intramedulary cutting guide
     • Start-point more medial on tibial plateau
     • This helps insure against inadvertent lateral tilt malposition of tibial component
     • Keep in mind posterior slope: more bone often taken anteriorly than posterior when doing the index HTO procedure
     • Results in loss of posterior slope
     • Correct to 7-10° of posterior slope when performing TKA
• Medial opening wedge HTO adds bone instead of removing so expect a larger medial tibial cut doing TKA
• Soft tissue balance may be complex due to typical findings of both varus knee (pre-HTO alignment) and valgus (post-HTO alignment)

7. Instability
• Soft tissue balance may be complex due to typical findings of both varus knee (pre-HTO alignment) and valgus (post-HTO alignment)

References:


Robertsson O, W-Dahl A. The risk of revision after TKA is affected by previous HTO or UKA. Clin Orthop Relat Res. 2015 Jan;473(1):90-3

Prior Infection
Arlen D. Hanssen, MD

The presence of prior or active bone or joint infection about the native knee joint is relatively uncommon in most orthopedic practices and yet is a clinical scenario that most clinicians will encounter at some time in their practice.

Typically these patients present clinically in a several different of ways:
1) ancient history of septic arthritis or osteomyelitis as a child
2) past history of infection associated with prior fracture and hardware implantation
3) past history of native joint infection treated by arthroscopic and / or open arthrotomy
4) evidence of active infection associated with any of above history

It is incumbent upon the clinician to determine whether active infection is likely or not and can be done by use of hematological screening tests, joint aspiration, occasional bone biopsy, and occasional use of nuclear imaging modalities. It is important to recognize that recent surgical intervention will often obscure these diagnostic modalities.

If it is believed that there is low evidence for active infection, we typically would treat the condition with primary knee arthroplasty using antibiotic-loaded bone cement providing that the patient is more than one year out from the most recent surgical intervention and use of any antibiotics. This one year waiting period was determined empirically and instituted in our practice several decades ago to improve the accuracy of diagnostic tests to rule out infection and allow for recurrence of infection in the absence of antibiotics if an infectious nidus remains.

It is not uncommon for a patient to present inside this one year window and have a desire for knee replacement. In this situation, the patient is counseled that if they can tolerate their symptoms to reach the one year mark and have no evidence of infection that the expectation of success with only one procedure exceeds 90%, if however, the patient is so functionally disabled due to severe arthritic changes or due to infection related bone loss and deformity, two-stage reconstruction is recommended. This is accomplished with joint resection and insertion of antibiotic-loaded cement spacers and reimplantation approximately three months later.

Presence of prior infection associated with a prior tibial plateau fracture portends the worst prognosis. In these cases, if hardware is present, open debridement with hardware removal and multiple cultures is preferred to proceeding with arthroplasty. Occasionally, with severe joint destruction it may be best to remove hardware and insert an antibiotic-laded cement spacer and treat the patient with a two-stage reimplantation protocol.

In the presence of active infection, it is important to assess the condition and function of the articular joint surfaces to determine the appropriate treatment course. If the joint function is so impaired so that the patient is severely compromised functionally, the most reasonable course is to treat the patient with a two-stage protocol.
References


Is Constraint Needed in Primary TKA?

Mark P. Figgie, MD

1. Use of constrained knees is not a substitute for ligament balancing
2. Goals of surgery should be to achieve a stable knee with the least amount of constraint required
3. Increased constraint leads to
   a. Increased polyethylene stress and wear
   b. Increased stress at the bone/cement interface
4. Knee designs with increased constraint
   a. Constrained condylar knees
   b. Rotating platform hinges
5. Biomechanics of these designs
6. Indications for increased constraint
   a. Flexion /extension mismatch with flexion gap loose
      i. CCK may not be appropriate if gap significantly larger as post capable of disassociating
      ii. Hinge may be required
   b. Flexion imbalance
      i. Lateral opening may require increased constraint
      ii. Posterior stabilized knees capable of dislocating with lateral instability
      iii. CCK may be needed
   c. Collateral ligament deficiency/absence
      i. CCK not a good option for MCL insufficiency- hinge may be required
      ii. CCK potentially could be used for lateral collateral deficiency
      iii. Hinge required when femoral resection above collateral ligament attachments
   d. Rarities
      i. Neuromuscular disorders
         1. Polio
         2. Multiple Sclerosis
      ii. Connective tissue disorders
         1. Ehlers Danlos
      iii. Charcot
      iv. Hyperextension
Joint restoration and preservation refer to biological or mechanical solutions to delay or prevent the progression to arthroplasty in younger more active patients. These patients are generally considered less than ideal candidates for arthroplasty given their age, and are looking for bridging techniques to help get them to an age that would be more suitable to arthroplasty. The therapeutic options can be broken down into three general categories: palliative, reparative, and restorative.

Advances in imaging have led to increased recognition of the presence of early evidence of chondral and meniscal abnormalities that may allow for improved detection of knees at risk. Increased field strength magnetic resonance imaging with 3 Tesla scanners allow for improved resolution of the articular surface. Fast-spin echo (FSE) sequences are best for identification of articular cartilage defects in the clinical setting. The use of T2 mapping and delayed gadolinium enhanced MRI for cartilage (dGEMRIC) allows one to assess the biologic activity of cartilage and is largely used in the research setting to evaluate the quality of tissue generated following interventions. The MOCART (magnetic resonance observation of cartilage repair tissue) scoring system is used to objectively report the findings for consistency in reporting.

There is great interest in non-surgical procedures for chondroprotection in at-risk joints as well as for palliation and/or cartilage repair in injured knees. Some have shown a reduction in COMP and other cartilage breakdown markers in acute ACL injury patients treated with aspiration and corticosteroid injection. While the initial injury that caused bone bruises cannot be undone, it is felt that the secondary inflammatory response leading to chondrocyte apoptosis may be the prime target for therapies to prevent subsequent degeneration. Finding genetic markers to detect who is at risk and who may be a candidate for interventions is a key research goal. In clinical practice, viscosupplementation, platelet-rich plasma (PRP), autologous conditioned serum, bone marrow aspirate concentrates, and stem cell injections are commonly requested by patients. The safety of such procedures has been well-documented, but their efficacy at cartilage repair is best described as unproven. However, patients may experience symptom relief, perhaps through such mechanisms as decreasing IL-1 effective levels. At present, these should be considered symptomatic treatments that would fall into the palliative category.

Surgical procedures focus on the articular surface, meniscus, ligament stability and alignment. Often, these procedures will be performed concomitantly to address not just the defect, but also to address the reason for its existence and to improve the environment for healing. Microfracture has been considered a standard against which the FDA compares newer technologies. This is a reparative technique leading to fibrocartilage tissue which may provide symptom improvement in the short-term, but there are concerns about worsening results after 2-5 years which are felt to be due to poor durability of this tissue and damage to the subchondral bone. Attempts to improve on this technique have resulted in a shift towards “nanofracture” with smaller, deeper drill holes and the use of membranes and scaffolds to trap the marrow elements (autologous matrix-induced chondrogenesis, AMIC).

Osteochondral grafting remains one of the most successful restorative techniques available today and has been increasing in popularity in the US. Autologous osteoarticular plugs (OATs) can be transferred for smaller defects with good results, but are limited by donor site morbidity in medium to large lesions. These
may be best treated with osteochondral allograft (OCA) which allows for restoration of the articular surface with mature bone and hyaline cartilage. Fresh grafts have the highest success rates in this class with many mid- to long-term studies. However, their utilization may be limited by timing and graft availability. This has led to other products designed to increase availability and potentially provide off-the-shelf alternatives. If allograft tissues are “minimally modified,” they do not require study by the FDA which has led to marketing of a number of below the bar products. The results of de-cellularized osteochondral plugs were reported in 2016 and found to have an unacceptable failure rate of 72% at 2 years. Cryopreserved grafts have not yielded viable chondrocytes in past studies, but have now returned to the market in a thinned out sheet of tissue that may allow for improved permeation of the solvent, but results are not available. Minced juvenile cartilage uses small cubes of cartilage from skeletally immature donors which have a higher chondrocyte density, are more metabolically active and further from senescence. Mid-term results are now available showing some efficacy.

Autologous chondrocyte implantation (ACI) was the first FDA-approved cell therapy in orthopedics and now has over two decades of results. While the Knutson et al. follow-up study published in 2016 failed to show an improvement over microfracture, several other studies have shown good-excellent results in a majority of appropriately selected patients. The latest generations of this 2-step cell expansion and surgical implantation involve providing the patients’ cells co-cultured in an absorbable matrix. “MACI” (Vericel, US) was approved by the FDA at the end of 2016 based on the results of several international trials showing high success rates. Studies using both autologous and allograft (amniotic) stem cell expansion and surgical implantation are underway at several centers in the US.

Scaffolds either with or without cell seeding offer another potential solution. The Holy Grail would be a scaffold which is easy to implant, has chondrogenic properties, integrates to the surrounding bone and cartilage, is stable enough to allow weight bearing, absorbs when the articular surface has been restored. Much of this research is being performed in Europe, where tissue banking is not as readily available as in the US. There are significant barriers to even getting acellular devices into clinical study in the US, much less a composite product which is both a biologic and a device.

Meniscal insufficiency is a strong predictor of progression to arthritis which highlights the importance of meniscal repair. Improved techniques and devices have made repairs of complete radial tears and root tears possible. Meniscal substitutes have been developed, but remain largely investigational. Meniscal allograft transplantation is a good bridging option in meniscal deficient patients with high 15-year survivorships reported.

References:


Unicompartmental Arthroplasty in 2017

Craig J. Della Valle, MD

Unicompartmental knee arthroplasty (UKA) has a long history that extends back nearly as far as the first tricompartmental designs. While initial results were erratic, with a greater understanding of patient selection and surgical techniques, more consistent and favorable results have been reported. While there has been somewhat of a resurgence in interest in UKA, the percentage of primary knee arthroplasties that are unicompartmental hovers around 6-8%. It is my belief that you should be doing more!

Several peer review studies suggest that with both fixed and mobile bearing designs, survivorship exceeds 90% at ten year. In our own initial series of 62 fixed bearing medial UKA, survivorship was 90% at 20 years.

UKA is an outstanding option for younger patients, who are amongst the most challenging to satisfy with a TKA. In a cohort of patients < 55 years old, Biswas et. al reported a mean KSS of just over 95 points and a mean UCLA activity score of 7.5. This is opposed to the report by Parvizi et. al who suggested 1/3 of young, active patients reported residual symptoms and limitations following modern TKA.

Most data suggests that UKA is a less morbid procedure than TKA. In a retrospective review of 605 UKA compared to 2235 TKA, Brown et. al found the risk of complications was 11% vs. 4.3% favoring UKA with a shorter length of stay and risk of discharge to an extended care facility, which also translates into lower costs for our health care system.

Finally, in the only randomized study that I am aware of that has compared UKA and TKA, UKA was associated with significantly better survivorship (90% vs. 79%). Further, UKA was associated with better ROM and functional scores at 5 and 15 years. Finally, recovery with UKA was faster and the risk of perioperative complications was lower.

References:
Despite the known benefits of total knee arthroplasty (TKA) up to 25% of primary TKA patients report not being entirely satisfied following surgery[1,3]. Both posterior cruciate retaining (CR) and posterior stabilized (PS) knee designs have demonstrated abnormal knee kinematics in gait and fluoroscopic kinematic studies. Retention of the ACL, with either unicompartmental knee arthroplasty or TKA, has been shown to provide more normal knee kinematics. Bipucruicate retaining TKA designs (BiCR) thus have the potential to improve patient satisfaction after TKA by virtue of more closely replicating normal knee kinematics.

Successful results have been reported with BiCR TKA including 82% survivorship at 22 years, with the majority of revisions due to polyethylene wear with the Cloutier Hermes 2C prosthesis[6]. In addition, in two separate studies, Pritchett et al.[4,5] reported strong (79-83%) patient preference for BCR knees when compared to contralateral CR or PS knees.

We recently reviewed our experience with a new BiCR TKA that was introduced to the market in 2013[2]. The purpose of that study was to examine the patient reported, clinical, and radiographic outcomes of BiCR vs. standard CR designs. We compared 66 BiCR TKA patients with 237 CR TKA patients that underwent surgery between January 2013 and May 2014 at a single academic medical center. Both linear and logistic GEE regression models were used to examine differences between groups for PROMIS physical function T-scores (PF-CAT) and PROMIS global health scores (global health, global pain, global mental T-score, and global social). These same models were used to assess knee ROM, joint A-P laxity measures, and postoperative radiolucent lines (RLL) between implant type. Multivariable hazard ratios were estimated by shared-frailty Cox regression model for reoperations between the groups.

There were no differences for any of the PROMIS scores postoperatively (p>0.05). Clinically, there was no difference in knee ROM or A-P joint laxity between BiCR and CR TKA patients (p>0.05). The overall reoperation rate, excluding manipulations, was 5% (15/303). BiCR TKA patients had significantly higher rates of irrigation and debridement with component retention (HR=0.07, p<0.001), and also had significantly higher rates of all cause revision (HR=7.44, p=0.028). No differences were found between groups for subsequent manipulation (p=0.137). The proportion of RLL was greater in the BiCR group (HR=2.93, p<0.001) at a minimum 12-month followup.

We concluded that although survivorship of BiCR implant design have been reported to be as high as 82% at 22 year followup, our early experience with a new design demonstrated higher early reoperation rates and a greater prevalence of radiolucent lines. These results could be explained by a number of factors including early learning curve experiences, a predilection toward intervention/revision due to the novel implant, and inferior implant design/surgical technique.

Nevertheless, there remains interest in the concept of bicruciate retaining TKA due to the potential for replication of more normal knee kinematics and improved patient satisfaction. Undoubtedly, as we expand the indications for TKA in younger more active individuals, patients will demand a more natural feeling and functioning TKA. Areas for future refinement will likely include identification of appropriate alignment goals with BICR TKA (e.g. kinematic vs mechanical), improvement in tibial component fixation, and optimization of bearing surface geometry to minimize kinematic conflict with a retained ACL.
References


Medial Pivot Design
C. Lowry Barnes, MD

The available implant choices for total knee arthroplasty (TKA) today are extensive. Because of the effectiveness of TKA, it is being used to treat end-stage arthritis in an increasingly younger population. This younger generation expresses a strong desire to continue an active lifestyle with a knee that feels more “normal”. Designs continue to try to solve the problem of 15-20% of patients not being extremely satisfied with their result following TKA.

The Medial Pivot TKA has been designed in an attempt to reproduce a more normal feeling knee. This Medial Pivot Knee System and its spherical congruency in the medial compartment and less conforming lateral compartment has been found to replicate the medial pivoting behavior observed in normal knees. The knee is more compliant on the lateral side and less compliant medially. It has also been found to exhibit anterior-posterior (AP) stability in activities such as gait and deep knee bend. Theoretically, this design should result in lower tibial insert wear due to its large contact area in the medical compartment and resulting in lower contact stresses.

Multiple studies have shown clinical and radiographic outcomes of TKAs implanted with a Medial Pivot Total Knee design. The majority of Knee Society clinical scores have been excellent or good. Studies have also shown through radiographic analysis that there is no evidence of progressive radiolucencies or osteolysis in this design. It has also been shown that in patients with bilateral TKA’s, the medial pivot system was more commonly preferred over the design implanted in the contralateral knee.
References


Higher Tissue Concentrations of Vancomycin with Intraosseous Regional Prophylaxis in Revision TKA
Simon W. Young, FRACS; Mei Zhang, PhD; Grant A. Moore, BSc; Rocco P. Pitto; Henry D. Clarke, MD; Mark J. Spangehl, MD

Introduction
In primary TKA, prophylaxis with low-dose vancomycin via intraosseous regional administration (IORA) achieves tissue concentrations 6-10 times higher than systemic administration, and was shown to provide more effective prophylaxis in an animal model. However in revision TKA the presence of a tibial implant may compromise IORA injection, and tourniquet deflation during a prolonged procedure may lower tissue concentrations. This study compared tissue concentrations of vancomycin administered intravenously (IV) versus IORA in revision TKA.

Methods
Twenty patients undergoing aseptic revision TKA were randomized to two groups. The IV group received 1g of systemic IV prophylactic vancomycin. The IORA Group received 500mg vancomycin as a bolus injection into a tibial intraosseous cannula, below an inflated thigh tourniquet before skin incision. During the procedure subcutaneous fat and bone samples were taken at regular intervals. Tissue vancomycin concentrations were measured using high performance liquid chromatography (HPLC).

Results
In all IORA patients, intraosseous tibial injection was unaffected by the tibial implant. Mean procedure length was 3.5 hours in both groups. Mean initial tourniquet inflation was 1.5 hours, with a second inflation for mean 35 minutes during cementation.
Overall mean tissue concentration of vancomycin in fat samples was 4.1ug/L in the IV group versus 115ug/L in the IORA group (p<0.001); tissue concentrations in femoral bone were 7.2ug/L in the IV group vs 101ug/L in the IORA group. Vancomycin concentrations in the final subcutaneous fat sample taken before closure remained 5.3 times higher in the IORA versus IV Group (p<0.001). The intra-articular concentration of vancomycin on post-operative day 1 drain samples was similar between the two groups (mean 4.6ug/L IV group vs 6.6ug/L IORA, p=0.08)

Conclusion
IORA administration of vancomycin is effective in revision TKA, resulting in tissue concentrations of vancomycin 5-20 times higher than systemic IV administration despite the lower dose. High tissue concentrations were maintained throughout the procedure, despite a period of tourniquet deflation. IORA may be more clinically important in revision TKA, where the risk of infection is higher.
Background Proponents of computer-assisted total knee arthroplasty (TKA) suggest that computer navigation will lead to improve the alignment and position of the TKA, thereby potentially improve patient function and survivorship of the implants. However, there is a little evidence in the literature whether the improved position and alignment of the TKAs by using computer-navigation improve the patient function and the longevity of TKA.

Questions/Purposes To determine whether: (1) clinical results; (2) radiographic and computer-tomographic (CT) scan results; (3) patient satisfaction; and (4) the survival rate of TKAs would be better in patients having a computer-assisted TKA than those in the patients having a TKA without computer-assisted TKA. In addition, we determined whether (5) complication rates would be less in the patients with computer-assisted TKA than those in the patients with conventional TKA.

Methods We prospectively compared the results of 282 consecutive cohorts (564 knees) with osteoarthritis. These patients had computer-assisted TKA for one knee and TKA without computer-assistance for the other. Fifty-nine men and 223 women were enrolled in the study. At the time of index arthroplasty, the mean age of patients was 59.4±6.7 years (range, 48-64) years. Patients were followed up at three months and at one year after the surgery and then two or three years thereafter. Knee Society knee score, Western Ontario and McMaster Universities Osteoarthritis (WOMAC) score, and University of California, Los Angeles (UCLA) activity score were obtained preoperatively and at each followup. The mean followup was 15.1 years (range, 14-16 years).

Results The Knee Society knee scores (93 vs 92 points), WOMAC scores (14 vs 15 points), range of knee motion (128° vs 127°), patient satisfaction (93% vs 94%) and UCLA patient activity scores (6.1 vs 6.1 points) were not significantly different between the two groups at 15.1 years followup. There were no significant differences in the radiographic parameters, including mechanical axis, femorotibial angle, position of femoral and tibial components, level of joint line, posterior condylar offset and the prevalence of radiolucent line between the two groups. Furthermore, rotational alignment of femoral and tibial components on CT scan was not significantly different between the two groups. No knee in either group had osteolysis. Two knees (0.7%) in each group had aseptic loosening of the components. Anterior femoral notching was observed in 11 knees (4%) with computer-assisted TKA group. Kaplan-Meier survivorship of the TKAs showed a 99.3% (95% CI, 93 to 100) in both groups at 16 years as the end points of revision or aseptic loosening of the components.
Conclusions Clinical results, radiographic and CT scan results, patient satisfaction, complication rate, and survivorship of the components were not significantly different between the TKAs with or without computer navigation. No effect of navigation has been demonstrated, except a negative one of anterior femoral notching. Comparison of bilateral TKAs may dampen differentiation regarding pain and functional scoring. This study is specific to a single navigation and total knee system.

Level of Evidence Level I, therapeutic study.
THE MARK COVENTRY, MD AWARD

A Randomized Clinical Trial on Patellofemoral vs. Total Knee Replacement for Patellofemoral Osteoarthritis
Anders Odgaard, Frank Madsen, Per Wagner Kristensen, Andreas Kappel, Jesper Fabrin

Background. Controversy exists over the surgical treatment for patellofemoral osteoarthritis. We aimed to compare the outcome of patellofemoral (PFA) to total knee arthroplasty (TKA) in a double-blinded RCT. The outcome was patient-reported (SF36, OKS, KOOS) and clinical.

Questions/purposes. Do patients recover quicker after PFA than after TKA? Do patients get a better range of movement after PFA than after TKA? Do patients obtain a better disease-specific and generic quality of life after PFA than after TKA? Does PFA result in more revisions and reoperations than TKA?

Methods. The study was conducted as a multicenter trial. Patients were eligible, if they had debilitating knee symptoms and isolated patellofemoral disease. One-hundred patients were randomized to PFA or TKA (double-blinded for the first year). Patients were seen for clinical follow-up and completed questionnaires. The current study reports on the full data for the first two years and 50 patients have been followed for more than five years. SF-36 bodily pain was primary outcome.

Results. The mean age at inclusion was 64.2 years (SD = 8.9), and 77% were females. Six weeks postoperatively, 93% and 46% of PFA and TKA patients, respectively, found that their knee had improved (p< 0.001). The preoperative range of movement was 132 degrees (SD=12.0), and at four months, one year and two years, the PFA group had a better range of movement than the TKA group (126 vs. 113 (p<0.001), 129 vs. 121 (p=0.002) and 130 vs. 121 (p=0.001)). The “bodily pain” and “physical functioning” of the SF-36, the “symptoms” dimension of the KOOS and the OKS showed all a significantly better result for PFA compared to TKA patients. The area under the PFA and TKA curve for the “bodily pain” was 9.4 vs. 6.6 months after two years (p=0.011). Similar figures were found for other patient-reported outcomes. During the observation period, there were three revisions (two PFA and one TKA) and no difference in reoperations.

Conclusions. PFA patients recover quicker than TKA patients, and the functional outcome is better for PFA patients. The average TKA patient looses almost three months of knee function during the first two years relative to a PFA patients. We believe that patellofemoral implants should be used rather than total knee arthroplasty for patients with patellofemoral osteoarthritis. We also believe that implant registers are unsuited for comparing implant types.

Level of Evidence. Level 1b, individual RCT
The entirety of the patient experience after contemporary total knee and total hip replacements in 2017 is markedly different from that encountered by patients just a decade ago. Ten years ago most patients were treated in a traditional sick-patient model of care and because they were assumed to require substantial hospital intervention, many cumbersome & costly interventions (e.g. indwelling urinary catheters, patient-controlled analgesic pumps, autologous blood transfusion, continuous passive motion machines) were a routine part of the early postoperative experience. Today the paradigm has shifted to a well-patient model with a working assumption that once a patient has been medically optimized for surgery then the intervention itself, hip or knee replacement, will not typically create a sick-patient. Instead it is expected that most patients can be treated safely & more effectively with less intensive hospital intervention. While as orthopedic surgeons we are enamored with the latest surgical techniques or interesting technologies most busy surgeons recognize that advances in perioperative pain management, blood management, and early-mobilization therapy protocols account for the greatest share of improvements in patient experience over the past decade.

One can think pragmatically to get ahead and stay ahead of 3 predictable physiologic disturbances that adversely impact rapid recovery after knee and hip replacement: fluid/blood loss; pain; and nausea. The modern orthopedic surgeon and his/her care team needs a simple strategy to pro-actively, not reflexively, manage each of those 3 predictable impediments to early recovery. Those surgical teams that routinely get ahead and stay ahead in each of those areas will routinely witness faster recovery, lower costs and greater patient satisfaction and that is clearly a win for patient and surgeon alike.

Effective pain management improves patient satisfaction, decreases hospital stay, and facilitates discharge to home. Today’s emphasis is on a multi-modal strategy that minimizes the use of opioids. Most protocols use preop medications including an NSAID, acetaminophen, an oral opioid and some include gabapentin. Regional anesthesia is typically preferred over general. Both peripheral nerve blocks and periarticular local anesthetic cocktail injections have proved as effective adjuncts in decreasing early postoperative pain. Postoperative oral medications delivered on a schedule, not just as needed, often include acetaminophen, an NSAID and some include gabapentin. Oral and parenteral opioids are reserved for breakthrough pain.

Post-Op Rehab/Physical Therapy

Matthew S. Austin, MD

The era of bundled payments has cast a spotlight upon the post-discharge care of patients after total joint arthroplasty (TJA). Upwards of 40-50% of the total episode-of-care for TJA may be incurred after the acute hospitalization. While the financial implications of post-discharge care are important, focusing on the needs of each individual patient should drive our decision making. Matching the needs of patients with an appropriate level of care may allow the healthcare system to balance this equation. So-called “demand matching” of implants to patient requirements has been previously reported in the literature and similar concept may be applicable to post-discharge care. The concept of demand matching requires a team approach to preoperative education, excellent pain management, and the support of the patient’s caregivers. It has being demonstrated that discharge to home without the need for home services or outpatient therapy may reduce complications and cost without compromising patient care. There may be a role for web-based modernization of the care process in order to improve patient satisfaction and engagement, particularly as the use of traditional services such as rehabilitation centers, home services, and outpatient physical therapy declines.
Patients undergoing TJA are at risk of developing venous thromboembolism (VTE) that includes deep venous thrombosis (DVT) and pulmonary embolism (PE). Data from 1990s suggested that without prophylaxis, the rate of DVT in patients undergoing TJA is reported to be between 35-84%, although the majority of these DVTs are asymptomatic. The etiology of VTE after TJA is multifactorial. It is important to note that there is a relationship between DVT and PE, especially in the context of lower extremity surgery as they are both part of a hypercoagulable state in the patient. However there are recent studies demonstrating that DVT and PE can occur independent of each other and the traditionally believed concept that DVT may mechanically propagate to the lungs has been questioned by a few recent studies.

Because of the relatively high risk of VTE following TJA, administration of prophylaxis is recommended. However, in recent years improvements in surgical and anesthetic techniques in combination with early patient ambulation has led to a significant reduction in the background rate of VTE. This reduction has, according to an analysis of the Nationwide Inpatient Sample database, resulted in a decreased economic burden from VTE in recent years. The decline in the rate of VTE following TJA, has provided the opportunity for less potent anticoagulation agents such as aspirin as an alternative for VTE prophylaxis after orthopedic procedures.

There is a wide and expanding array of VTE prophylaxis agents that may be administered to patients undergoing TJA. It is generally accepted that the more potent agents for prophylaxis, such as low molecular weight heparin (LMWH), warfarin, or the newer anticoagulation agents, result in a higher rate of bleeding and wound related complication. Aspirin on the other hand has been shown to be an efficacious agent for prevention of VTE with a lower risk for bleeding or wound related complications. Aspirin is well tolerated, inexpensive, and easy to administer with no need for routine blood monitoring. With the endorsement of aspirin by many published guidelines and the additional emerging evidence demonstrating its efficacy, aspirin has been continuing to gain popularity among the orthopedic community as a VTE prophylaxis agent following TJA.
Bilateral one stage total knee replacement has a number of advantages. There is one operative procedure and anesthetic and overall recovery time is significantly reduced. It is a more cost effective procedure in that acute hospital stay is less and although rehabilitation time is greater in the short term overall it is less. Additionally if there is a bilateral flexion contracture present there is an inevitable loss of extension if a single knee is operated upon as this knee will assume the position of the unoperated knee. Patients greatly prefer having both knees corrected at one operative setting rather than having to have the inconvenience and pain associated with a second operative procedure at three to six months after the first one.

There are potential disadvantages to a one stage procedure. One concern has been that there is more perioperative morbidity associated with one stage bilateral total knee replacement. In a review of 501 patients undergoing bilateral one stage total knee replacement at the Hospital for Special Surgery there were no perioperative deaths, myocardial infarctions or cerebrovascular accidents. There were arrhythmias present in 5% of patients. Fat emboli were present in 3% and 2 patients (0.4%) had pulmonary emboli. The average transfusion requirement was 2.6 units and allogeneic blood was required in 42%. There were 2 deep infections, 3 hematomas and 5 patients with delayed wound healing. There was an increased incidence of major complications in patients with ASA classification 3 and with increasing age over 70 years.

New data indicates perioperative administration of hydrocortisone my mitigate lung injury as demonstrated by reduction in cytokine and desmosine levels in a randomized trial. There was also a trend toward less need for narcotic medication and better range of motion in the steroid treated group.

Patient selection is important and all patients are screened preoperatively by an internist and anesthesiologist. In over 3000 bilateral TKR at HSS infection rate and mortality were lower than in the unilateral total knee replacement patients. Much of this has is due to patient selection criteria. All patients underwent the procedure with epidural anesthesia with postoperative epidural PCA for 48 hours. All patients are discharged on warfarin and spend the operative night in the recovery room. The procedure has acceptable morbidity and great advantage in properly selected patients.

1. Pavone, V; JohnsonT; Saulog PS; Sculco, TP, Boettner, F Perioperative morbidity in bilateral one stage total knee replacement, Clin Orthop Relat Res: 421:155-61, 2004
Instability currently represents one of the main causes of residual pain and symptoms following TKA and thus is a major cause of revision total knee replacement, second only to component loosening in some series (1). Instability related to ligamentous laxity can be categorized by the pattern of relative laxity of the soft tissue structures and this can lead to special attention to the overall bony alignment of the limb, component sizing or positioning issues and ligamentous abnormality which may be contributory and may require adjustment or correction.

Instability patterns associated with TKA can be categorized by the plane of the predominant excess laxity into Medial-Lateral (ML) or Anterior-Posterior (AP) instability. There can also be symmetrical (global) instability where there is laxity in all planes, or more commonly asymmetrical instability where there is excessive laxity in mainly one direction. Isolated laxity problems can be sub categorized into one of 3 patterns: ML instability (mainly in extension), AP laxity (mainly in flexion), and much less commonly Recurvatum, which is excess laxity in the AP plane mainly in extension. (2,3) Global laxity can occur due to inadequate tibial component thickness, or globally incompetent soft tissues, and can present initially right after TKA or alternatively can develop late from slow stretch of soft tissues over time as can be seen with some pathologic states (i.e. inflammatory arthritis, Ehlers-Danlos syndrome, neurogenic conditions such as polio, etc.)

Assymetrical or Isolated ML Instability generally occurs in the sagittal plane when medial versus lateral “gaps” are unequal. This may be due to contracture of tight structures either medially or laterally or can be due to insufficiency or injury of the ligamentous structures on one side vs the normal structures on other side. Occasionally there is a combination of both contracture on one side and attenuation/stretch on the other side as seen in some patients with severe long standing genu varum or genu valgum.

AP Instability is assymetrical laxity in the frontal plane which results in unequal extension versus flexion “gaps”. This can cause either anteroposterior laxity in flexion but full extension with good stability or alternatively, there may be AP stability in flexion but a lack of full extension from the exact same pattern of imbalance when a “too thick” polyethylene insert is used to correct what would otherwise be flexion instability. In both cases the cause is an extension gap that is tighter than the flexion gap.

Isolated recurvatum occurs when the posterior capsular structures are relatively lax or deficient so that a knee that is otherwise stable in the medial lateral plane in extension, and is stable in the AP plane when in flexion, hyperextends in the fully extended position. In any TKA procedure it is critical to understand the effect of selected bone resection (or build ups) on soft tissue balancing in order to avoid or treat ligamentous laxity:

- distal femur – effects extension gap only
- posterior femur – effects flexion gap only
- proximal tibia – both flexion and extension spaces
PREVENTION of instability is preferred over treatment and this requires careful assessment during surgery of the medial/lateral balance in extension and checking of the “gaps” in both extension and flexion to be sure they are equal. This can be done using spacer blocks, laminar spreaders, tensioning devices, or the trial components (or some combination of these).

When treating instability, careful evaluation of the cause(s) of the laxity and is critically important, especially if there is associated axial malalignment which generally must be corrected or compensated for in order to have any reconstruction or revision components succeed long term. (3) Most knees revised for instability issues will require a posterior stabilized or constrained (unlinked) condylar design. Constrained condylar implants are used to compensate for residual medial–lateral imbalance still present after standard soft tissue releases medially (subperiosteal tibia) or laterally (usually via selective pie-crusting). (4,5) However, if the patient displays residual major medial-lateral or global instability that cannot be corrected, or when there is an excessive flexion gap that cannot be stabilized with adjusted component placement and sizing, a rotating hinge design may be required. Recent data has shown that rotating hinges can work reliably in restoring stability to the knee in such cases with satisfactory durability and clinical results over time.

In summary, the careful assessment of instability pattern and associated contributing factors followed by a step wise approach to soft tissue balancing (preferred) vs increased constraint (when required) results in reliable improvements in function and symptoms during complex TKA, even in the face of major deformity or ligamentous imbalance.

Patellar instability after total knee arthroplasty (TKA) is a serious complication that impairs functional outcome and may lead to further surgical intervention or revision surgery. Its etiology can be related to the surgical technique, including mal-rotation with internal rotation of the femoral or tibial components, component positioning, extensor mechanism imbalance, and overstuffing of the patellofemoral joint with oversized components. Following TKA, the presence of anterior knee pain with mal-tracking of the patella, especially during activities requiring knee flexion, is indicative of patellar instability. Diagnosis can be made by radiological evaluation of component position and alignment. The use of CT is currently considered the gold standard to measure the degree of rotation of the femoral and tibial components. Nonsurgical management for patella subluxation or dislocation is rarely successful. Since femoral or tibial component malposition is often the etiology of patellar instability, revision of the mal-aligned or mal-rotated TKA components is usually required. Proximal realignment for patellar instability in the setting of properly positioned and sized components is associated with good results.

References


Chronic extensor mechanism insufficiency around TKA is a very challenging pathology to treat. An insufficient extensor mechanism negatively affects implant survival and patient outcomes. There are several risk factors for extensor mechanism disruption and the surgeon should be aware and avoid these problems in the perioperative period. In appropriately selected patients, reconstruction of the extensor mechanism is a valid option. Whole extensor mechanism and Achilles tendon allograft reconstruction of the deficient extensor mechanism have been proposed with good early published results. These reconstructions however are expensive and with time may stretch and lead to recurrence of an extensor lag. An alternative to allograft, is the use of marlex mesh as popularized by Browne and Hanssen. This technique uses a knitted monofilament polypropylene mesh that is secured to the patients’ native lateral tissue and covered by an appropriately dissected and distalized vastus medialis muscle. The technique can be used for both patellar and quadriceps tendon deficiencies and can be done with or without implant revision and is currently the treatment of choice at the presenters institution. The surgeon should be aware of the complexity and limitations of these three reconstructive techniques.
Instability can develop after revision TKA due to implant loosening, ligament laxity, or flexion/extension soft tissue imbalance. Instability may be associated with pain and swelling after activity, and giving way symptoms during ambulatory activity. However, extensor mechanism deficiency can also cause giving way symptoms particularly during walking down inclined surfaces, which should be differentiated from symptoms due to ligament insufficiency.

Flexion instability, which can occur after primary cruciate retaining as well as posterior stabilized TKA, can also develop after revision TKA. Instability in flexion may occur with intact collateral ligaments but imbalanced flexion and extension gaps. Flexion instability can be a consequence of revision TKA to treat patella infera if more distal augments are used on the femoral component to lower the joint line, resulting in a relatively tight extension space and loose flexion space.

Two types of constrained implants are generally available to treat instability – constrained condylar and hinge implants. The constrained condylar provides mediolateral and rotational constraint as a result of the rectangular PS post which fits into the rectangular PS box of the femoral component. The hinge includes an axle mechanism to prevent mediolateral movement. The hinge is more rigid in preventing mediolateral movement since it contains a metal axle mechanism while the constrained condylar implant relies on a polyethylene post which can deform or wear over time. Instability associated with intact but attenuated or imbalanced collateral ligaments can be treated with the constrained condylar implant while loss of one or both collateral ligaments is more effectively treated with a hinge device.
Patient satisfaction is a subjective and vague measure of outcome after total knee arthroplasty (TKR). In the past, the orthopaedic surgeon may have felt that performing a technically sound surgery that realigns the limb, restores a functional range of motion, and provides a stable joint, would result in a satisfied patient. Numerous studies have shown however that patient satisfaction with TKR typically occurs in only 80-90% of patients (1, 2). This still leaves a significant portion of patients who are unsatisfied with their TKR. There appears to be disagreement or discordance between surgeon and patient about outcome following TKR, with surgeons more frequently being satisfied with the outcome of the procedure than their patients (3). Changes in healthcare reimbursement based on patient satisfaction, and our desire to better meet the needs of our patients has, however, created a need for improved understanding about patient satisfaction after TKR.

Selecting the appropriate patient for the total knee replacement and optimizing the patient’s physical and medical condition before surgery is essential in order to minimize complications and insure a satisfied patient. Several studies have shown that patients with knee arthritis of a mild or moderate degree (Kellgren-Lawrence changes of ≤ 3) are more likely to be dissatisfied with TKR than patients with severe grade 4 OA of the knee (4,5). Addressing modifiable medical risk factors such as obesity, diabetes, smoking, depression and lack of social support before surgery have been shown to decrease risks of complications and improve outcome following TKR. This is essential since one of the strongest predictors of patient dissatisfaction after TKR are complications after surgery (1, 3, 6).

Pain relief is one of the most predictable outcomes of TKR and failure to achieve this is also one of the strongest predictors of dissatisfaction after TKR (7). Poorly controlled perioperative pain can limit the patient’s ability to mobilize and recover after surgery and can adversely impact the patient’s outcome and satisfaction after TKR. As a result, a comprehensive pain management program is recommended for all patients undergoing TKR. This should include a contemporary multimodal pain management program including regional anesthesia, periarticular blocks and minimization of narcotic analgesics.

Many patients undergoing TKR have other causes for their pain such as spinal stenosis and hip arthritis. It is important for both the patient and surgeon to have a good understanding of the potential etiologies for the patient’s pain prior to surgery, so that realistic expectations about pain relief following TKR are established. Patients with chronic pain syndrome, opiate dependence, anxiety, depression or “catastrophizing” should have these issues addressed preoperatively since they are important risk factors for dissatisfaction with pain relief from TKR and a poor surgical outcome (7, 8).

Although pain relief and development of complications are major concerns after TKR, unmet patient expectations have an even more significant effect on patient satisfaction (1-3, 7). In a prospective cohort study involving 322 TKR patients, Tilbury et al reported that 12 of 19 expectations on the Hospital for Special Surgery Knee Arthroplasty Expectation Survey were unfulfilled by more than 30% of patients at one year post-op(9). These included ability to kneel down, squat, walk for up to 1.5 km, walk up and down stairs and return to recreational and sports activities. Several others studies have demonstrated that unfulfilled expectations about functional abilities and activity after surgery are a major source of dissatisfaction with TKR (3, 11). This appears to be even more of a concern with younger patients who
frequently expect to return to a level of activity that may not be compatible with joint replacement surgery (6, 10).

Direct to consumer marketing by physicians and orthopaedic manufacturers about the latest orthopaedic “innovations” has given many patients the unrealistic impression that knee replacement will provide them with “normal” function, a lifestyle with no activity restrictions and perhaps turn back the clock by decades. It is essential that the orthopaedic surgeon remember that the primary goal of TKR is to relieve pain, restore the TKR patient to a reasonable level of activity and educate the patient accordingly.

A comprehensive preoperative patient education program is an effective mechanism to understand the patient’s expectations, provide them with realistic expectations after TKR, and minimize the discordance in expectations between patient and surgeon (12). An ongoing dialogue between surgeon, patient and family about patient specific expectations of TKR - both prior to and after surgery - is essential to understand and align the expectations of all regarding pain relief, function, appropriate activity and the surgical episode of care in general.

References:
Introduction: With the rise of patient reported outcomes as an important indicator of the success of elective procedures, “patient satisfaction” has become the benchmark for assessment of different surgeons, procedures and implant designs. This raises many different issues, not the least of which is “What is “patient satisfaction?”” and “How can it be measured?”

“Satisfaction” may be defined as “fulfillment of a need or want”, “patient satisfaction as “a state of contentment with health care received from their health care provider” In measuring satisfaction with knee replacement, ambiguities arise not so much in determining whether patients are or are not contented , but what they are content with. Is it their knee symptoms, their knee function, their decision to have knee replacement surgery, the whole experience of undergoing the procedure and the post-op recovery, or the capacity of the replaced knee to live up to the patient’s preconceptions?  We performed the following study to examine the hypothesis that the wording of questions measuring the satisfaction of patients after TKR has a significant effect on the responses received and thus the perceived success of the procedure.

Methods: The dilemma in assessing patient satisfaction in a valid, reliable and reproducible way has been tackled by several groups of investigators, including the developers of the New Knee Society Score. During the development of the New KSS, we administered a prototype questionnaire to 243 patients at a minimum of one year post-knee replacement. The questionnaire included a series 10 questions asking each respondent to describe their degree of satisfaction with their knee replacement surgery in terms of the degree to which it:

(i) improved their ability to lay in bed, rise from bed, getting in/out of a car or bus, perform light domestic duties, perform leisure recreational activities and to ascend stairs, and
(ii) reduced knee pain when sitting or lying, walking on a flat surface, and going up and down stairs.

Patients were also asked their overall level of satisfaction with the results of their knee replacement surgery.

We also explored the utility of alternative questions commonly used to assess patients’ perception of the value of elective treatments. Two such queries are: “Knowing what you know now, (i) would you recommend this procedure to your best friend or a family member? and (ii) Would you choose to undergo this procedure again?” Patients were also asked “Does your replaced knee feel normal?” The responses to these items were compared to the estimates of each patient’s degree of satisfaction based on the items within the satisfaction sub-scale of the New KSS.

Results: Analysis of the response to this part of the questionnaire showed that, when directly asked their degree of satisfaction with TKR, only 7% of patients responded that they were either dissatisfied or neutral with respect to the procedure, whereas 19% were satisfied and 74% were extremely satisfied with their overall result. However, when asked about their satisfaction with their pain relief when climbing stairs, the dissatisfaction/neutral responses increased to 16%, with only 55% of patients being very satisfied. Similarly, 17% of patients were dissatisfied or neutral about their knee function in performing leisure activities, with just over half (54%) reporting that they were “very satisfied”.

There was a highly significant correlation between response to the indirect questions and the overall satisfaction of the respondents. 47% of patients who were reported being very dissatisfied, dissatisfied, and neutral reported that they would undergo TKR again versus 95% of those who were satisfied and very satisfied (p<0.0001). A similar separation was seen in the percentage of patients who would recommend the operation to a friend or family member (53% vs 100%, p<0.0001), and the percentage of patients who indicated that their knee “never felt normal “ after TKR (41% vs 3%, p=0.0251) (Figure 1).
Discussion: Previous developers evaluating patient’s perceptions of treatment outcomes have observed that direct questions, such as “How satisfied are you with your replaced knee?” are inherently ambiguous. In practice, numerous factors influence how patients internalize their symptoms and function, no doubt weighted according to the demands and expectations of each individual. This is expected to cause subjective evaluations of the procedure to vary substantially from patient to patient, with what seem to be simple, direct enquiries acting as surrogates for confounding variables characterizing the delivery of care and not the outcome. The New Knee Society Score was developed recognizing these sources of ambiguity, and so has 5 items devoted to assessment of patient satisfaction (satisfaction with pain relief while sitting and lying in bed, and satisfaction with knee function when getting out of bed, performing light household duties, and leisure recreational activities). The responses to these items are averaged to generate the overall satisfaction score. Conversely, the Short-form version of the KSS contains only one item to assess satisfaction, namely the patient’s assessment of their knee function when performing light household duties as this item was shown to have the strongest correlation with the original 5-item satisfaction score derived from the full-length version of the New KSS.

Thus, satisfaction with the outcome of total knee replacement is expected to depend on a combination of several factors. Consequently, each patient’s objective status may be less significant than the degree to which the patient is conscious of their artificial joint, or the belief that their treatment was successful in providing the outcome that they envisioned prior to surgery.

In previous work we have demonstrated that dissatisfaction with the results of total knee replacement are strongly correlated with the presence of residual symptoms which thwart the patient’s ability to perform those activities that they consider most important.

Figure 1. Distribution of patients agreeing with the statements listed, plotted as a function of their satisfaction with the result of TKR.
TKR provides excellent pain relief and improved physical function in patients with advanced arthritis of the knee. Patients that will not achieve the expected improvement in physical function or pain relief; or who are at higher risk for adverse events, complications, re-admissions, or revision surgery are poorer surgical candidates.

Can we identify patients at risk for poorer outcome after TKR pre-operatively?

The Chitranjan Ranawat Award; The Knee Society Annual Meeting 2008


- 8050 primary, unilateral TKR patients enrolled in prospective registry
- Evaluated associations between function at 12 months with pre-op gender, age, BMI, emotional health (MCS), knee diagnosis, quadriceps strength, physical function (PCS) and post-op pain relief
- More than 98% reported post-op pain relief (KS score)
- At 12 months the mean PCS gain was 13.6 points, but the distribution was bimodal
- 63% of the patients with greater improvement the mean PCS gain was 21 (SD=7) and was 4.1 (SD=7) in the remaining 37%
- Increased likelihood of poor functional gain was associated with older age, BMI over 40, Lower MCS, and poor quadriceps strength.
- While 2/3rds of patients reported functional gain well above the national average at 12 months post-TKR, 37% reported limited functional gain

Conditions associated with higher complication rate:
1. High Charlson Score; Multiple Medical or Orthopedic Co-Morbidities
   - Ayers et al. Outcomes After TKR Vary on the Basis of Preop Coexisting Disease in the Lumbar Spine and Other Nonoperatively Treated Joints; The Need for a MSK Comorbidity Index. J Bone Joint Surgery (Am), 2013 95(20)1833-1837

2. Poor nutritional status

3. Diabetes

4. Obesity or Morbid Obesity
• Thornqvist et al. BMI and risk of peri-op cardiovascular adverse events and mortality in 34,744 Danish patients undergoing hip or knee replacement. Act Orthopaedica 2014:85(5):456-462

5. Cardiac Disease
• Kumar et al. Risk of post-TK Acute MI in Patients with a history of MI or Coronary Stent, Clin Orthop Relat Res (2016) 474: 479-486
• Basilico et al. Risk Factors for Cardiovascular Complications Following Total Joint Replacement Surgery, Arthritis &Rheumatism, 58 (7): 1915-1920
• Aggarwal et al. Patient with Atrial Fibrillation Undergoing TJR Increase Hospital burden, J Bone Joint Surg (Am) 2013; 95:1606-1611

6. Renal Failure/Dialysis
• McCleery et al. Rates of infection and revision in patients with renal disease undergoing TKR in Scotland, J Bone Joint Surg (Br) 201; 92B:1535-1539.
• Warth et al. TJR in Patients with Chronic Renal Disease: Is It Worth the Risk? J of Arthop 30 Sup1 (2015) 51-54
• Miric et al. Can TKR be safely performed in patients with chronic renal disease? Acta Orth. 2014; 85 (1) 71-78
• Cavanaugh et al. Complications and Mortality in Chronic Renal Failure Patients Undergoing TJR. J of Arthrop. 31 (2016) 465-472

7. Low SES

8. Previous Surgery
• Robertsson et al. The Risk of Revision after TKA is Affected by Previous HTO or UKA. CORR (2015) 473: 90-93.

9. Pulmonary Disease/Smoking

10. Chronic Narcotic Use
• Franklin et al. Reduction in Narcotic Use After Primary TKA and Association with Patient Pain Relief and satisfaction J Arthroplasty 2010,25(6Suppl)12-16
11. Worker's Compensation
   - Mont et al. TKA in Patients with Worker’s Compensation. J Bone and Joint Surg (Am) 1998;80(9):1285-1291

Because patients have different risk profiles there is a need for improved risk adjustment methodology when comparing TKR outcomes
Overall the majority of patients undergoing total knee arthroplasty are satisfied with their results. However, data from various joint replacement registries all demonstrate dissatisfaction rates of 15-20%. Patient satisfaction appears to be related to a variety of factors including: pre and post-operative pain and function, unmet patient expectations, duration of disease and status of health related quality of life. Psychological factors can also influence satisfaction. One way to improve satisfaction rates is to identify patients with risk factors for dissatisfaction and to discuss these issues with the patient prior to surgery.

References
While TKA generally has favorable clinical outcomes in patients with advanced OA, there remains a risk of unfavorable outcomes. This includes operative and post-operative complications potentially leading to readmissions or revision surgery. Often these suboptimal outcomes are tied to comorbidities or complications associated with their TKA. Modifiable risk factors for poor clinical outcomes following TKA include: 1. morbid obesity, 2. poorly controlled diabetes and nutrition, 3. Staphylococcus aureus (S. aureus) colonization, or hepatitis C and/or HIV infection, 4. cardiovascular disease, 5. venous thromboembolic disease (VTED), 6. tobacco use, 7. neurocognitive, psychological and behavioral problems (including drug or alcohol dependency) and 8. physical deconditioning, frailty and fall risk. Together, these eight modifiable risk factors significantly account for avoidable complications and poor clinical outcomes following TKA. Identifying and modifying these risk factors prior to surgery presents an opportunity to decrease avoidable complications, improve clinical outcomes, and decrease costs associated with unnecessary health services utilization following these procedures.

Although some of these modifiable risk factors may be longstanding and recalcitrant to change, patients may express a renewed interest in addressing them if they stand in the way of obtaining THA, a procedure they hope will result in dramatic changes in pain, physical function and quality of life. The prospect of undergoing TKA may therefore provide an opportunity (i.e. “teachable moment”) to identify and manage such modifiable risk factors through shared decision making. Primary care physicians, internists and specialty physician involved in the pre-admission clearance process can all participate in decreasing these risk factors preoperatively. By implementing these risk factor optimization programs, we were able to lower our complications after TKA operation and our readmission rates. The concept of a Perioperative Orthopaedic Surgical Home (POSH) to optimize patients preoperatively is the NYULMC plan to deal with these difficult patients.

Comorbidity Prevalence in TJA patients
Musculoskeletal comorbidities 73.8%
Hypertension 60.1%
Hyperlipidemia 55.3%
Tobacco use 22.0%
Diabetes 19.2%
Depressive disorders 14.5%
Morbid Obesity 13.8%
Ischemic Heart Disease 13.5%
Dysrhythmias 10.8%
Valve disease 7.8%
Cerebrovascular Disease 4.4%
CHF 2.8%
Characteristics of patients with multiple risk factors for SSI that need intervention based on evidence from Maoz et al and Crowe et al

Additionally, the patients with comorbidities that did not have a readmission may have an increased risk of a complicated initial hospitalization: 506/2772 TJA patients had a length of stay of 7 days or longer with average costs of $32,609-$84,678 per admission, substantially higher than our average of $24,000 during that time period. The vast majority (95%) of increased length of stay or readmitted patients had at least 1 modifiable risk factor in their history. Additionally, about 50% had 2 or more modifiable risk factors. We have validated a POSH RRAT Readmission Scoring Tool which quantifies modifiable risk factors and predicts readmission risk, thus identifying patients who would benefit from surgery delay and risk factor optimization.
POSHP Risk Factor Scoring Tool, RRAT

### Risk Factor Scoring Tool, RRAT

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Points on Risk Stratification Scale</th>
<th>Notes on Risk Stratification Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infection risk factors</strong></td>
<td></td>
<td>Hard Stop</td>
</tr>
</tbody>
</table>
| Staphylococcus Aureus colonization |  | If possible for staphylococcus colonization:  
  - Nasal mupirocin or providone-iodine, chlorhexidine gluconate (CHG) wipes, and appropriate antibiotic coverage  
  - If these requirements are not met then hard stop until protocol implemented |
| **Smoking (Tobacco use)** |  | Hard Stop |
| All tobacco users will be enrolled in tobacco cessation program 4 to 8 weeks prior to surgery |
| **Obesity** |  | Hard Stop |
| BMI greater than 40:  
  - Enroll in nutritional counseling program  
  - Long-term weight loss program, and  
  - Undergo bariatric consult |
| BMI 35-40:  
  - Patients will be enrolled in nutritional counseling with consideration of acute weight loss program |
| BMI 30-35:  
  - Enroll in nutritional counseling program |
| **Cardiovascular Disease** |  | Hard Stop |
| Patient has history of coronary artery disease (CAD), stroke, peripheral vascular disease or VTED, age ≥50 years and 2 cardiac risk factors: renal insufficiency (CrCl < 60mL/min); Diabetes; chronic obstructive pulmonary disease; Hypertension; Recent smoker (<30 days); Cancer; Heart failure  
  - All qualifying patients will be enrolled in OPTIMIZE-OS perioperatively |
| **Venous Thromboembolic Disease** |  | Hard Stop |
| History of pulmonary embolism or deep venous thrombosis:  
  - Consider inferior vena cava (IVC) filter or aggressive VTED management  
  - Have VTED risk factors: CVA, COPD, BMI >30, CAD, stroke, PVD, activated protein C resistance |
| **Neurocognitive, psychological, and behavioral problems (including alcohol and drug dependency)** |  | Hard Stop |
| Alcohol abuse or chronic active narcotic dependency  
  - Neurocognitive deficits such as traumatic brain injury (TBI), active psychiatric illness, dementia etc.  
  - Score of 7 or more on catastrophizing, PHQ-9 |
| **Physical Deconditioning** |  | Hard Stop |
| Nonambulatory or needs assistance with transfers status  
  - Comorbidities affecting physical function and ambulation |
| **Diabetes** |  | Hard Stop |
| Fasting blood glucose >180  
  - Must be corrected prior to surgery, consider referral to diabetic management clinic (endocrinologist)  
  - High A1c >8  
  - Referred to diabetic management clinic (endocrinologist)  
  - Wall controlled DM |

### Risk Ratio at each POSH Readmission Scoring level (for the random set)

<table>
<thead>
<tr>
<th>POSH Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Readmitted (A)</td>
<td>21</td>
<td>36</td>
<td>37</td>
<td>45</td>
<td>49</td>
<td>43</td>
<td>24</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>None (B)</td>
<td>89</td>
<td>95</td>
<td>39</td>
<td>31</td>
<td>12</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ratio = A/B</td>
<td>0.24</td>
<td>0.38</td>
<td>0.95</td>
<td>1.45</td>
<td>4.08</td>
<td>14.33</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OR (Linear)</td>
<td>0.19</td>
<td>0.41</td>
<td>0.89</td>
<td>1.94</td>
<td>4.21</td>
<td>9.14</td>
<td>19.86</td>
<td>43.12</td>
<td>93.64</td>
</tr>
<tr>
<td>OR (Non-Linear)</td>
<td>0.24</td>
<td>0.38</td>
<td>0.95</td>
<td>1.45</td>
<td>4.08</td>
<td>14.33</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OR (Linear, Age)</td>
<td>0.18</td>
<td>0.40</td>
<td>0.90</td>
<td>1.91</td>
<td>4.56</td>
<td>10.23</td>
<td>20.20</td>
<td>44.68</td>
<td>104.24</td>
</tr>
<tr>
<td>OR (NL, Age)</td>
<td>0.23</td>
<td>0.37</td>
<td>0.95</td>
<td>1.48</td>
<td>4.26</td>
<td>15.21</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Patients with a POSH Score of 3 had a 1.94 times higher risk of readmission, and with a score of 4 had a 4.21 times higher risk of readmission. This represents an overwhelming opportunity for cost savings, improvement in care and improvement in quality of life for our TKA patients.

Optimization interventions based on modifiable risk factors

- MRSA Screening and Decolonization, weight based antibiotic dosing, and use of Vancomycin and Gentamycin in high risk patients
- Aggressive HIV and HCV treatment optimization
- Smoking cessation (hard stop)
- Cardiovascular Optimization and Stroke Prevention (using PT, High dose Statins, and ACE inhibitors perioperatively)
- Aggressive weight control (hard stop at a BMI of 40)
- Catastrophizing avoidance
- Drug and alcohol interventions
- Fall education prevention, Frailty screening
- Physical deconditioning physical improvement interventions
- Diabetes control and nutritional interventions
- Screening for high risk VTED patients with thrombophyllia testing and risk stratification in order to avoid aggressive anticoagulation

Modifiable risk factors do play a major role in outcomes post TKA. By addressing these issues and enrolling patients in a risk modification program prior to surgical intervention, we may be able to lower rates of complications associated with these procedures. In light of these findings, we are implementing a Peri-operative Orthopaedic Surgical Home (POSH) model that allows for risk stratification of TKA candidates and clinical treatment to mitigate modifiable risk factors in high-risk patients. At NYULMC HJD, we have incorporated a trans-departmental (anesthesia, internal medicine, pulmonary, cardiology, endocrine, nutrition, bariatrics, physical therapy and psychiatry) approach to decrease perioperative morbidity and mortality and decrease readmissions. In today’s bundled payment and quality driven environment, it is no longer economically feasible to simply accept increased risk in poorly managed patients. We have chosen to take an active role in managing modifiable risk factors and will delay surgery until these risk factors are controlled. We are funding a risk stratification coordinator to facilitate management and optimization of modifiable risk factors. At NYULMC HJD we are in year 3 of the BPCI program. There were 721 Medicare primary TJA patients in year 1 (January 1, 2013 to December 31, 2013) and 785 in year 3 (June 1, 2014 to May 31, 2015) available for analysis. Average hospital length of stay was decreased from 3.58 days to 2.96 days. Discharges to inpatient facilities decreased from 44% to 28%. Number of readmissions at 30 days decreased from 7% to 5%; at 60 days decreased from 11% to 6.1%; and at 90 days decreased from 13% to 7.7%. Although improved care coordination can assist in increasing efficiency of care and controlling costs, it does not prevent all complications and readmissions. Patient selection and risk optimization is the key to decreasing readmissions and complications associated with patient related factors.
References

- Boraiah, Sreevathsa; Joo, LiJin; Inneh, Ifeoma; Rathod, Parthiv; Meftah, Morteza; Band, Philip; Bosco, Joseph A. III; and Iorio, Richard: A Readmission Risk Assessment Tool to Manage Modifiable Risk Factors Prior to Primary Hip and Knee Arthroplasty. Journal of Bone and Joint Surgery, 2015, 97(23):1921-1928 (# 1863582)
- Crowe, Brooks; Payne, Ashley; Evangelista, Perry; Stachel, Anna; Phillips, Michael; Slover, James; Inneh, Ifeoma; Bosco, Joseph; and Iorio, Richard. Risk Factors for Infection Following Total Knee Arthroplasty;
• Singh JA, Lewallen DG. Predictors of Activity Limitation and Dependence on Walking Aids after Primary Total Hip Arthroplasty. JAGS. 2010; 58:2387-2393.


Surgical site infection is defined by the CDC as at or near the operative site within thirty days of the surgical procedure or within one year, if an implant is in place. There are three major sources of infection that include the patient, surgical team and the hospital environment. The most common pathogens are the normal skin flora that are present on the patient as well as the health care worker and include staph aureus and staph epidermis. There are approximately 27 million surgical cases in the United States each year and forty percent of all surgical site infections are hospital acquired infections. Colonization of a patient with bacteria precedes an infection in thirty to sixty percent of cases and oftentimes these bacteria are spread by the hands of health care workers that act as reservoirs for the bacteria. Surgical site infections are associated with prolonged hospital stays, double the rate of readmission in three times the overall health care costs compared to patients who do not develop infections.

Deep periprosthetic infections around a total joint arthroplasty remain a formidable challenge to the patient and the surgeon. The literature ranges anywhere from 0.5% to 2% after primary total hip and total knee replacement. A study by Bozic, that looked at the epidemiology of revision total knee arthroplasty showed that up to 25% of all revision knees between October 2005 and December 2006 were for deep periprosthetic infection. Kurtz has also shown that the number of revisions done for infection is on the rise and by the year 2030, over 60% of all revision total joints may be for a diagnosis of infection.

With these concerning trends for infection, it is imperative that we attempt to minimize risk factors which are known to lead to deep periprosthetic infection. This generally falls into two categories, optimizing the host and optimizing the surgical and perioperative environment. The majority of patients are in suboptimal health leading up to their surgery. Eliminating or diminishing modifiable risk factors should, however, decrease their overall risk for the development of a deep periprosthetic infection. Direct scientific evidence to make evidence based recommendations, however, does not currently exist for many of the risk factors that we deal with. There are multiple modifiable risk factors that affect patients prior to surgery.

Diabetes

Diabetes has reached epidemic proportions in the United States. It is associated with multiple comorbid health conditions and patients have demonstrated a higher complication rate and longer hospital stays following surgery. In addition, Marchant, has shown a 2.8 times increased risk of infection after total joint arthroplasty in patients with uncontrolled diabetes.

Surgical stress increases the production of counter regulatory hormones that antagonize insulin and predispose patients to hyperglycemia. Hemoglobin A1C is a marker of long term glucose control and may take three months to change. Ideally, patients with optimal blood glucose control should have a hemoglobin A1C less than 7 prior to surgery. It appears that Perioperative hyperglycemia, however, is associated with a greater risk of development of post operative infection. Post operatively, blood glucose should be maintained between 110 and 180 grams per deciliter. These patients may often require frequent blood sugar checks post operatively and it has been shown that a standard diabetic algorithm following surgery can minimize the risk of hyperglycemia.
Obesity

Obesity, likewise, has reached epidemic proportions in the United States. These patients are at high risk for the development of osteoarthritis and are increasingly requiring the need for total joint arthroplasty. Most outcome data in total joint arthroplasty, in the obese population, is comparable to the non-obese population with regards to functional improvement and longevity. However, the obese patient is susceptible for increased risk of infection secondary to longer surgical times, greater surgical dissections, poorly vascularized subcutaneous tissue, a high calorie, but poor nutritional diet, inadequate prophylactic antibiotics that are not adjusted for weight, and a pathologic relationship with Type II diabetes. Several articles in the literature have shown increased risk of deep infection on obese patients following total joint arthroplasty. Namba et al, in 2005, showed that obese patients were at a 6.7 times higher risk for the development of infection following total knee arthroplasty compared to a non-obese population. Malinzak showed that patients with a BMI of greater than 40 had a 3.3 times increased odds of developing an infection. When the BMI increased to 50 the odds increased to 21 times the risk of infection compared to the non-obese patient. In addition, Waniarsky, showed a 22% wound complication rate in the morbidly obese patient compared to 2% in a control group. It is therefore critical that we optimize a patient’s weight through education, counseling and occasionally surgical intervention to try and diminish their risk for the development of infection prior to surgical intervention.

Malnutrition

Several patient groups are at risk for malnutrition. These include the elderly population, those with gastrointestinal problems, alcohol abuse, and cancer. Green in 1991 showed that malnourished patients were at 5 to 7 time’s greater risk in the development of infection following total joint replacement. Simple blood tests can help screen patients at risk for malnutrition prior to surgery. These include a total lymphocyte count of less than 1,500, a serum albumin of less than 3.5 grams per deciliter or a transpharen level of less than 200 milligrams per deciliter. Patients with pre-operative malnutrition should be counseled and strategies implemented to improve nutritional intake prior to surgery.

Smoking

Nicotine causes micro vascular constriction and increases carboxyhemoglobin, which decreases the delivery of oxygen to tissues. This places patients at increased risk for post operative wound complications following surgery. It has been shown that a smoking cessation program, even within four to six weeks of surgery can decrease complications associated with the use of nicotine.

HIV/AIDS

The increase in longevity of patients with HIV and AIDS will introduce a new subset of patients that will require total joint arthroplasty. The literature has only a small series of patients with HIV/AIDS who have undergone total joint arthroplasty and the results have been mixed. There are specific risk factors, however, that place these patients at increased risk for infection. These include a CD four count of less than 200 and a viral load of greater than 10,000. It is important that the patient and surgeon work in conjunction with an infectious disease doctor to optimize these patients prior to surgery.

Urinary Tract Infection

The association between a pre-operative urinary tract infection and the development of a post operative infection is unclear; however, all patients in their pre-operative work up, should be asked about symptoms of a urinary tract infection prior to surgery. In general, the recommendations are that it is okay to proceed
with surgery if the patient has bacteria (greater than 10,000 cells per milliliter) without symptoms or symptoms are present and they have less than 10,000 cells per milliliter. These patients can generally be treated with a standard oral antibiotic. It is recommended that surgery be postponed in any patient that shows signs of obstruction of the urinary pathway or has a symptomatic UTI and greater than 10,000 cells per milliliter.

Poor Oral Health

It is well supported in the literature, the relationship between bacteremia and dental procedures after total joint arthroplasty and yet, there is no scientific literature on pre-operative screening. In general, one should use a common sense approach. Patients should have a dental exam and clearance if they have evidence of decayed teeth, abscess, gingivitis, or periodontitis and should have routine cleanings done prior to surgical intervention.

Pre-Operative Anemia

Post operative allergenic blood transfusions are a risk factor for the development of surgical site infection. Blood transfusion has been shown to be associated with a transfusion related immune modulation response. Every unit of blood transfused increases the risk of infection. It is important therefore to establish an algorithm for blood management. Several studies have demonstrated the efficacy of the use of erythropoietin prior to surgical intervention to maximize patient’s hemoglobin level prior to surgery.

Pre-Operative Staph Screening

Molecular DNA studies have shown that the majority of infecting strains of staph are part of the patient’s resident nasal flora. These rates can be as high as 85% in an at risk patient population. The goal of screening, therefore, would be to decrease the incidence of post operative staph aureus surgical site infections by eliminating staph aureus as a nasal carrier from the patients prior to surgery.

A study by Kim in 2010 looked at the implementation of a pre-screening program for the detection and eradication of MRSA in patients undergoing elective orthopaedic surgery. Patients were identified using a rapid PCR of nasal swabs and were treated with intranasal Mupirocin and Chlorhexidine showers prior to surgery. They showed a colonization rate of 22.6% in the staph aureus group and 4.5% in the MRSA group. With this pre-screening and decolonization program, they were able to reduce their surgical site infection rate by 59%. Rao, in 2008, identified 26% of all patients undergoing orthopaedic surgery as carriers of staph aureus prior to surgery. They were also treated with a five day course of Mupirocin and Chlorhexidine baths and they reduced their surgical site infections from 2.6% to 1.5%. This resulted in an institutional savings of $231,000.00 dollars as a result of decreased surgical site infections.

Antibiotic Prophylaxis

Pre-operative prophylactic antibiotics are effective in reducing the rate of surgical site infections in orthopaedic patients. Routine prophylactic antibiotics should include a first generation cephalosporin, i.e. Ancef for patients with a known allergy to Beta lactam, Clindamycin or Vancomycin and should be administered in place of cephalosporins. Prophylactic antibiotics should be administered ideally as near to the time of the incision as possible, but within sixty minutes prior to the incision for a first generation cephalosporin or Clindamycin and within two hours of incision for Vancomycin. The routine use of Vancomycin for antibiotic prophylaxis remains controversial. It is generally recommended that Vancomycin
be the antibiotic of choice for those patients who have been shown to be colonized with Methicillin
resistant staph aureus or had had a previous infection with MRSA.

Surgical Site Preparation

The current evidence based recommendations and best practice guidelines recommend the use of
Chlorhexidine Gluconate based solutions for surgical site preparations prior to surgery\(^3, \, 8\). This has been
found to be superior to both alcohol, as well as, ion based solutions at reducing or eliminating bacteria
from the surgical site prior to surgery.

Operating Room Environment

There are several operating room environment factors that may or may not diminish the risk of
Perioperative infection following total joint arthroplasty. These can include the use of body exhaust suits,
laminar flow in the operating room, ultraviolet light, the type of gloves, and antibiotic coated suture\(^24\). One
factor that does appear to affect the rate of infection in the operating room is the operating room traffic\(^23\).
It is clear that an increasing number of personnel in the OR is directly related to increased risk of infection.
It is therefore imperative that the surgeon and his operative team maintain a strict OR environment and
limit the flow of operating room traffic during the procedure.

Conclusion

In conclusion, doing everything possible to minimize modifiable risk factors for the development of deep
Periprosthetic infection is imperative. It is clear that an ounce of prevention is worth a pound of cure.
Unfortunately, there is little in the literature to guide us on how to manage many of these issues. It is
important that we use common sense and a practical approach and be vigilant in minimizing modifiable
risk factors.

References:

2. Bong MR, Patel V, Chang E, Issack PS, Hebert R, Di Cesare PE. Risks associated with blood
3. Bosco JA, 3rd, Slover JD, Haas JP. Perioperative strategies for decreasing infection: a
comprehensive evidence-based approach. [Review] [67 refs].
5. Bozic KJ, Ries MD. The impact of infection after total hip arthroplasty on hospital and surgeon
1751.
7. Corwin HL. Transfusion practice in the critically ill: can we do better? Crit Care Med. Jan
8. Fletcher N, Sofianos D, Berkes MB, Obremskey WT. Prevention of perioperative infection. [Review]
[184 refs].
10. Furst DE. Anakinra: review of recombinant human interleukin-I receptor antagonist in the treatment
of rheumatoid arthritis. [Review] [81 refs].
27. Winiarsky R, Barth P, Lotke P. Total knee arthroplasty in morbidly obese patients.
When Is Irrigation and Debridement Indicated for Infection?

David J. Mayman, MD

Introduction: Unicompartmental knee arthroplasty (UKA) has shown to be a reliable treatment option for isolated medial osteoarthritis. Recently, a systematic review on national registries showed 91.7% survivorship at 5-year follow-up of 88,648 UKAs. Successful clinical outcomes following UKA depend on lower limb alignment, soft tissue balance and component positioning, which can be difficult to control using manual instrumentation. Although robotic-assisted surgery is more reliably controls these surgical factors, studies assessing outcomes of robotic-assisted UKA are lacking. Therefore, a retrospective single center study was performed to assess the five-year-survivorship rates of robotic-assisted medial UKA performed by two high volume UKA surgeons.

Methods: A total of 245 consecutive patients who underwent robotic-assisted medial UKA surgery from two surgeons at one institution between 2008 and 2011. All patients received a fixed-bearing metal-backed implant as tibial component. Each patient was contacted by mail, telephone or in office evaluation at a minimum five-year follow-up to determine survivorship. Of 245 patients, 178 patients were available for follow-up and included in our study. Sixty five patients were lost to follow-up.

Results: Data was collected for 178 patients at a minimum 5 year follow-up (Mean follow-up 6.5 years). At five-year follow-up, 9 patients underwent additional surgery on the operative side and 6 knees were reported revised, resulting in a survivorship of 97%.

Conclusion: In this single center study, robotic-assisted medial UKA was found to have high survivorship rates at mid-term follow-up. Larger prospective comparative studies with longer follow-up and functional outcomes are necessary in order to compare survivorship of robotic-assisted UKA to conventional UKA and total knee arthroplasty.

References
Two-Stage vs. One-Stage Treatment of Deep Infection in 2017

Fares S. Haddad, MD

The infected joint arthroplasty continues to be a very challenging problem. Its management remains expensive, and places an increasing burden on health care systems. It also leads to a long and difficult course for the patient, and frequently a sub optimal functional outcome. The choice of a particular treatment program will be influenced by a number of factors. These include the acuteness or chronicity of the infection; the infecting organism(s), its antibiotic sensitivity profile and its ability to manufacture glycocalyx; the health of the patient; the fixation of the prosthesis; the available bone stock; and the particular philosophy and training of the surgeon.

For most patients, antibiotics alone are not an acceptable method of treatment, and surgery is necessary. The standard of care for established infection is two stage revision with antibiotic loaded cement during the interval period and parental antibiotic therapy for six weeks. Although three have been multiple developments to enhance our ability to effect two-stage techniques whilst limiting inpatient stay, cost and patient morbidity - these include functional spacers, the use of local as well as systemic antibiotics, and home intravenous therapy programmes – there is nevertheless still a considerable morbidity and mortality to the two-stage process, and a massive cost to the patient who has to have two operations with an unpredictable interval period in between and to the local tissues which have already been damaged and are violated on two occasions.

The push for one-stage surgery has generally been from centres who are passionate about that technique and has involved a combination of knowing the organism in question prior to surgery, a very radical debridement, the use of hinge / tumour-type implants and prolonged antibiotic therapy post-surgery.

The last decade has seen an evolution whereby we have recognised that treatment may be tailored to the patient. There is a big difference between a relatively healthy host and someone with multiple comorbidities, and a big difference between infection with a relatively benign organism and polymicrobial infection with multi-resistant bacteria or fungi.

There has, therefore, been increased interest in the use of single-stage revision in order to decrease morbidity, potentially decrease mortality and to decrease cost to the healthcare system. Single stage revision may have economic and functional advantages. We have devised a protocol that dictates the type of revision to be undertaken based on host, organism and local factors.

Whilst we believe that there is a role for both single and two-stage techniques in our armamentarium, we have gradually evolved to increasing use of single-stage surgery. Our protocol has included single stage revision using antibiotic loaded cement / local antibiotic delivery in both THA and TKA. This was only undertaken when sensitive organisms were identified preoperatively by aspiration and appropriate antibiotics were available to use locally. Patients with immune-compromise, multiple infecting organisms or recurrent infection were excluded. Patients with extensive soft tissues defect that required flaps were also excluded.

The analysis of single versus two stage revision for the infected arthroplasty will be enhanced by having a uniform definition of infection, agreed outcome measures and by the funding of prospective randomized studies both in the UK and in the USA to study this subject.
References:


Optimizing Patient Health Status and Improving Outcome for TJA: Using Population Health Management to Deliver Value-Based Care

Joseph A. Bosco, III, MD

Population Health: The health outcomes of a group of individuals, including the distribution of such outcomes within the group. (Kindig and Stoddart 2003)

Population Health Management: The aggregation of patient data across multiple health information technology resources, the analysis of that data into a single, actionable patient record, and the actions through which care providers can improve both clinical and financial outcomes. (https://www.wellcentive.com/what-is-population-health-management/)

The following road map has been suggested for helping healthcare organizations navigate the path toward implementing effective population health management.

- Establish precise patient registries
- Determine patient-provider attribution
- Define precise numerators in the patient registries
- Monitor and measure clinical and cost metrics
- Adhere to basic clinical practice guidelines
- Engage in risk-management outreach
- Acquire external data
- Communicate with patients
- Educate patients and engage with them
- Establish and adhere to complex clinical practice guidelines
- Coordinate effectively between care team and patient
- Track specific outcomes

(Sanders, Dale A Landmark, 12-Point Review of Population Health Management Companies. Retrieved 2014-03-17)

How is Population Health and Population Management applied to enhance value in total joint arthroplasty; identifying patients at risk for complications prior to surgery enables providers to address and mitigate these risk factors, thus decreasing the risk of complications. Potentially modifiable risk factors include tobacco use, obesity, poorly controlled diabetes and nasal colonization with staphylococcus aureus species. (5). It is ethically acceptable for providers to insist that these risk factors are addressed prior to performing an elective procedure, even if it results in a delay of a procedure. (3) Additionally, identifying these risk factors allows surgeons to provide a more accurate estimation of the magnitude of risk to potential patients, thus improving the patient’s ability to make an informed decision as to whether to proceed with the surgery. This is the hallmark of shared decision making. (1) For example Maoz and colleagues determined that patients who smoke, are obese and have nasal staph aureus nasal colonization are at a tenfold higher risk of developing a surgical site infection following hip replacement. (4) This data may dissuade a patient from undergoing a joint replacement, or may motivate them to modify these risk factors prior to surgery.

Risk factor identification also allows the more effective use of finite resources. The Readmission risk assessment tool (RRAT) is a questioner which identifies patients at risk for readmission following joint
replacements. Identifying patient at high and low risk for readmission allows providers to shift resources from low risk to high risk patients, thus making more efficient use of available resources. (6) Risk factor identification allows for more accurate risk stratification. For example the CJR stratifies risks by diagnosis and also by the presence of major co-morbidities. Identifying major co-morbidities places these patients into a different DRG (469 vs. 470) and allows for higher reimbursement. As a result of our understanding of the different costs and outcomes associated with hip replacement for fractures vs., hip replacement for arthritis, the hip fracture patients are no longer compared to the non-fracture arthroplasty patients when the bundled costs are calculated.

Adopting and utilizing evidence based clinical pathways (EBCPs) is essential to managing patients attributed to a bundled payment episode of care. Adhering to EBCPs decreases variation in care and outcomes both on an individual provider and institutional based level. To maximize utilization of EBCPs each stakeholder should be allowed to the development and application of the pathways. Thus, each stakeholder assumes ownership of these pathways. This becomes important as most bundled care arrangements involve a large number of providers whose practices vary based on their different experience and knowledge levels. Using accepted EBCPs decreases the care and outcome variation inherent in large groups of providers. Equally as important, the collective expertise and experience amassed by high volume providers, both at an individual provider and institutional level, is incorporated into EBCPs. Once developed, these EBCPs can be adopted by low volume providers including both physicians and institutions, thus transferring the experience, expertise and improved outcomes achieved by high volume providers to low volume providers. (2,8,10)

Examples of EBCPs which result in improved outcomes at a reduced cost include institutional wide venous thromboembolism (VTE) prevention and blood management clinical pathways. Institutional wide VTE prophylaxis pathways ensures that each patient receives the most appropriate level of VTE prophylaxis in order to best balance the risk and rewards of VTE prevention in total joint arthroplasty. These pathways insure that patients of low volume providers, who may not have the experience in VTE prophylaxis receive the same quality prophylaxis as the patients of more experienced providers. This decreases the variation in care and leads to improved outcomes and more cost effective care. (13)

A comprehensive evidenced based blood management pathway in which decision making and transfusion ordering is controlled by an electronic medical record creates value by decreasing transfusion rates. These pathways incorporate the latest evidence based transfusion triggers in addition to incorporating the use of tranexamic acid to decrease blood loss. Value is created when costly blood transfusions and the increased complication rates associated with these transfusions are avoided. (10,14) Post-operative pain management EBPCs decrease physician specific variation and result in reduced opioid consumption, decreased length of stay and enhanced functional recovery. (11,12)

Accurate, actionable and contemporary data is essential for the cost effective management of a bundled episode of care. The federal government’s voluntary BPCI and its mandatory CJR and SHFFT bundled programs are reconciled retrospectively. This means that all costs are paid by the federal government in the traditional fashion. Then the total episode associated costs are compared against a target price. If the total paid costs fall below the target price than the providers receive a portion of the difference in a bonus payment (provided they have met certain quality metrics). If the total episode costs are in excess of the target price, then the providers must pay the government a portion of the difference. The issue is that the government reconciles these costs months after the episode of care is over. (30) Thus any issues that increase the cost of care, such as high readmission rates and high utilization of post-acute inpatient rehabilitation need to be addressed as they occur in order to avoid increased cost and decreased quality. Those providers who rely on the government’s reconciliation to track readmissions and post-acute costs must wait months to get this data. This precludes these providers from addressing these issues in real time. Those providers who have invested and developed a robust data collection and dissemination
infrastructure, are at a competitive advantage as they learn about problems soon enough to correct them. (31)

This data must be readily accessible to all providers involved in the bundle. It also must be transparent and provider specific. If used correctly, transparent, provider specific data identifies outliers and fosters changes in behavior. Additionally, accurate, transparent, provider specific data enables those who manage the bundled payment programs to make data driven decisions including allocating resources in an efficient manner. For example, providers with high readmission rates are readily identified and resources can be applied to understanding and correcting the reasons for these rates. Institution wide and provider specific SSI rates are time sensitive. The soon issues with SSIs are identified, the quicker they can be corrected. Those providers with the fastest access to this data have a competitive advantage over their peers. This is important as both the CJR and SHFFT programs will eventually compare costs between institutions located in geographic regions in order to determine which institutions are financially rewarded and which are penalized.

Using data to identify variations in outcomes and costs is the hallmark of quality programs. Variations in outcomes present an opportunity for quality improvement. For example, the costs of hip and knee prosthesis can vary widely between providers. Rarely if ever do the providers with highest implant cost have the improved outcomes to justify these costs. Programs which identify high implant cost surgeons and which use reference pricing to decrease total cost and cost variation have been successfully used for both total joint prostheses and spine implants (15,16). Additionally, tracking implant waste allows identification of waste patterns, and increases awareness of the value lost when implants are wasted. (17). Data which tracks VTE rates, SSI rates, readmission rates, post discharge costs is an essential component to managing bundles. As stated above, those providers who have access to the most accurate, timely data, and who use it to drive decision making enjoy a competitive advantage over their peers who do not have access to high quality, actionable data. (20,22)


Partnering with the Patient to Improve Outcomes in TJA: The Role of Shared-Decision Making in Advising Patients of Risk and Comorbidity Burdens

Kevin J. Bozic, MD, MBA

In shared decision making (SDM), both physicians and patients make necessary contributions to the dialogue about a patient’s condition and best way to achieve the optimal outcome for that patient. The physician provides expert clinical knowledge of conditions, treatment options and associated risks and benefits, and limitations of evidence. The patient contributes their goals, preferences, and values (Wennberg 2009).

There are tools and strategies that can help clinicians and patients engage in shared decision making. Decision aids, which can be various formats including DVDs, booklets, and web-based tools, present patients with information on their condition, treatment options and associated risks and benefits, and help patients assess their goals and preferences. Communication aids can take the form of prompt sheets or health coaches. One example is a health coach that helps patients develop question lists for their health care provider to ensure they get information that is important for their decision making process. Questionnaires can be used to assess patients’ knowledge of their condition or treatment options, their values and preferences, and their decision status.

The use of decision aids has been shown to improve knowledge and lead to more accurate perception of risks (Stacey 2014). Decision aids have also been found to lower decisional conflict, reduce proportions of people who were passive in decision making, and reduce the proportion who were undecided (Stacey 2014).

In a randomized trial of SDM in patients with osteoarthritis of the hip and knee, patients in the intervention group received decision aid in the form of a DVD with an accompanying booklet that provided information on treatment choices for hip and knee osteoarthritis. Prior to their visit, patients had a question listing consultation with a pre-medical intern to develop a focused written list of questions for their surgeon. After their visit, patients received an audio recording of their office visit and a copy of their surgeon’s dictated note (Bozic JBJS 2013). Patients in the intervention group were more likely to reach an informed decision during the first visit, and had higher confidence in knowing what questions to ask their doctor. Surgeons reported higher satisfaction with the intervention group visits. There were no significant differences in the duration of the office visits or the proportion of patients choosing surgery for the treatment of their hip or knee osteoarthritis. (Bozic JBJS 2013)

Patient-reported outcomes (PROs)–assessments of symptoms and function directly from the patient–can inform the shared decision making process. PROs may be used to allow clinicians to better predict post-operative patient outcomes. In one study, pre-operative PROs (Knee Injury and Osteoarthritis Outcome Score [KOOS] score) predicted whether patients achieved minimally clinically important difference (MCID) in post-operative KOOS score (Berliner 2016). A threshold effect was detected; above a certain level of pre-operative function, the patient’s chance of achieving a MCID in function post-operatively fell. Mental health scores also played a role. With lower mental component scores, patients had lower thresholds for achieving MCID–i.e., these patients have lower probability of achieving a MCID for a given level of preoperative function (Berliner 2016). Collecting and using PROs in clinical decision making could also improve patient engagement (involving patients in their own care through collaboration, behavior change, and new technologies), if patients’ data are shared with them and used to engage patients in shared decision making.
Using PROs in the decision making process can help ensure appropriate treatment is offered, based on patients’ function and symptoms. A patient’s physical and mental health may show that they have a substantial impairment in physical function, but poor coping skills, and therefore may benefit from cognitive and/or behavioral therapy before considering surgery. Another patient may have moderately impaired physical function, good coping skills, and decide to proceed with surgery. At some point after surgery, their scores could be used to evaluate the success of the procedure in terms of reducing pain, improving physical and mental health, and quality of life.

Shared decision making using patient-reported outcomes should be incorporated into routine clinical care. Tools such as decision aids, personalized for each patient, could allow more precise estimates of the potential risks and benefits of treatment options and help ensure appropriate treatment. Incorporating SDM tools and use of PROs into practice will require training and careful attention to implementation, but the benefits to patients and providers could be substantial in terms of enhancing knowledge and decision quality and confidence, improving the efficiency of the consultation, and identifying appropriate candidates for surgery.

References


Through listening to clinicians and engaging as partners, the Centers for Medicare and Medicaid Services (CMS) has been able to develop innovative payment reforms. Collectively we have made great progress on transforming our delivery system into one that provides better quality of care for patients and pays for care in a smarter way.

This presentation will provide a high level overview of current policies such as the Medicare and CHIP Reauthorization Act (MACRA) Quality Payment Program (QPP). The QPP is centered on clinician choice and accountability, allowing clinicians to choose the best way to deliver quality care and to participate in the program based on their practice size, specialty, location or patient population, while rewarding them based on the quality of care they provide. It has 2 tracks: 1. The Merit-based Incentive Payment System (MIPS) and 2. Advanced Alternative Payment Models (APMs). We will discuss it in the broad context and more specifically as it relates to hip and knee surgeons. Finally, we will open for a discussion about some challenges to participating in these emerging opportunities.
The Role of Registries, PROs, and Quality Measures in Improving Value and Outcomes and Determining Physician’s Payment: This is Our Future!

David C. Ayers, MD

- PROs support the IOM vision for 21st Century to use information technology to support patient-centered, evidence based decisions
- As healthcare moves to a value based reimbursement system PROs are used to define outcomes and quality and therefore are the numerator of the value equation
- PROs have moved into clinical Practice In TJR
  - Ayers, Bozic. The Importance of Outcome Measurement in Orthopedics
    CORR 471: 3409-3411, 2013
  - Orthopedic surgeon reimbursement in US increased by PRO reporting in PQRS through FORCE-TJR
  - Pay for Performance Quality Reporting; Pilot project by BC of MA
  - PROs used for negotiations with insurance companies, ACOs and referring MDs as a measure of quality
- PROs can be collected in a busy practice with >85% follow-up at 1 year
  - Ayers, Franklin. Integrating PRO into Ortho.Practice; Proof of Concept from FORCE-TJR
    CORR: 471(11) 3482-3488, 2013
- PRO must bring value to visit; real time scoring; CAT enabled
- PRO used for Shared Decision Making and part of routine clinical care, not “research”
  - Ayers. Patient-Reported Outcomes Move into Clinical Practice.
    Orthopedics Today. August 2014
- FORCE-TJR has collected >35,000 patients PROs (Pre-op, 6M and 1 Yr Post-op with 86% collection rate).
  1. Franklin, Allison, Ayers. Beyond Implant Registries; a Patient-Centered Approach to TJR.
    - National TJR research registry and Comparative effectiveness consortium based at University of Massachusetts Medical School
    - Currently includes >225 sites in >28 states in the US
    - Established by a $12 Million P50 Grant from AHRQ
    - Currently collects and measures Level 1,2,3, and 4 data
    - Establish PRO standards at the surgeon and hospital level
    - Now using FORCE platform and infra-structure members manage bundled payment programs with CMS and private payers
    - FORCE –TJR feedback to surgeons/hospitals for quality improvement and real-time operational data to manage bundle payment programs
      - Patient characteristics/mix/ Charlson co-morbidity index
- Patient selection (timing of surgery)
- Medical and ortho co-morbid conditions
- Discharge location/ use of ancillaries
- TJR outcomes including post-TJR pain and function
- TJR outcomes also including adverse events/ readmissions/return to surgery/ revision surgery
  - FORCE-TJR Now open to new member enrollment

- PROs used to evaluate patient mix at the hospital/surgeon level for medical and MSK co-morbidities
  - Used to answer how do my patients compare to FORCE-TJR cohort on key risk-adjustment factors
  - *Ayers, et al. Patient Reported Outcomes After TKR; Need for MSK Co-Morbidity Index JBJS-A: 95(20)1833-7, 2013*
- Patient Selection and Timing of Surgery; Appropriateness
  - How do my patients compare to other sites on pre-TJR pain and function?
  - *Ayers, Franklin. Pre-Op Pain and Function Profiles Reflect Consistent TKA Patient Selection Among US Surgeons. CORR: Jan 2015, 473(1) p76-81*
- TJR patient reported outcomes;
  - How does my risk adjusted 1 year pain and function scores compare to FORCE-TJR national cohort?
  - Surgeons/hospitals want to improve!
- PROs improve risk adjustment models for readmissions
  - FORCE-TJR and AAHKS showed that adding pre-op function (PCS), BMI as continuous variable, smoking, modified Charlson co-morbidity score, Orthopedic co-morbidities improve readmission model from CMS C=.62 to FORCE-TJR C=.78
- PROs used to evaluate Cemented vs. Cemented TKRs; risk adjustment for PROs based on patient characteristics
- PROs already play an important role in clinical practice in TJR and will play an increasingly vital role in assessing quality and value in the future
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.

CREDIT HOURS
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.

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.

FDA STATEMENT
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.

The Knee Society policy provides that “off label” uses of a device or pharmaceutical may be described in The Knee Society’s CME activities so long as the “off-label” status of the device or pharmaceutical is also specifically disclosed (i.e. that the FDA has not approved labeling the device for the described purpose). Any device or pharmaceutical is being used “off label” if the described use is not set forth on the product’s approved label.

To obtain information regarding the clearance status of a device or pharmaceutical refers to the product labeling or call the FDA at 1-800-638-2041 or visit the FDA internet site at http://www.fda.gov/cdrh/510khome.html

FINANCIAL DISCLOSURE
Each participant in The Knee Society Specialty Day Meeting has been asked to disclose if he or she has received something of value from a commercial company, which relates directly or indirectly to the subject of their presentation.

The Knee Society does not view the existence of these interests or commitments as necessarily implying bias or decreasing the value of the author’s participation in the 2017 The Knee Society Specialty Day Meeting.
THE KNEE SOCIETY EDUCATION COMMITTEE:

Stephen J Incavo, MD, Chair  Submitted on: 11/30/2016; Innomed: IP royalties; Journal of Arthroplasty: Editorial or governing board; Knee Society: Board or committee member; Kyocera: IP royalties; Nimbic Systems: Stock or stock Options; Osteoremedies: IP royalties; Smith & Nephew: IP royalties; Wright Medical Technology, Inc.: IP royalties; Zimmer: IP royalties; Paid consultant

Keith R Berend, MD  Submitted on: 04/19/2016; AAOS Board of Specialty Societies (Knee Education Representative): Board or committee member; American Association of Hip and Knee Surgeons: Board or committee member; Clinical Orthopaedics and Related Research: Editorial or governing board; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Editorial or governing board; Knee Society: Board or committee member; Orthopedics: Editorial or governing board; Orthosensor: Research support; Pacira: Research support; Reconstructive Review: Editorial or governing board; SPR Therapeutics, LLC: Research support; Stock or stock Options; Zimmer Biomet: IP royalties; Paid consultant; Research support

Kevin J. Bozic, MD, Past Chair  Submitted on 10/25/2016: American Joint Replacement Registry: Board or committee member; Centers for Medicare Services: Paid consultant; Harvard Business School: Paid consultant.

Ryan Nunley, MD  Submitted on: 12/14/2016; American Association of Hip and Knee Surgeons: Board or committee member; Biocomposites: Paid consultant; Biomet: Research support; Blue Belt Technology: Paid consultant; Cardinal Health: Paid consultant; DePuy, A Johnson & Johnson Company: Paid consultant; Research support; Halyard: Paid consultant; Medical Compression System Inc: Paid consultant; Medical Compression Systems, Inc.: Research support; Medtronic: Paid consultant; Microport: IP royalties; Paid consultant; Mirus: Paid consultant; Missouri State Orthopaedic Association Board Member: Board or committee member; Smith & Nephew: Paid consultant; Research support; Southern Orthopaedic Association Board Member: Board or committee member; Stryker: Research support

Bryan Donald Springer, MD  Submitted on: 12/05/2016; 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; Osteoremedies: Paid consultant; PixarBio: Stock or stock Options; Stryker: IP royalties; Paid consultant

Timothy M Wright, PhD  Submitted on: 05/04/2016; Exactech, Inc: IP royalties; Stock or stock Options; Knee Society: Board or committee member; Lima: IP royalties; Mathys Ltd: IP royalties; Orthobond: Stock or stock Options; Stryker: Research support; Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support
PRESENTERS AND MODERATORS

Matthew Austin, MD Submitted on: 10/25/2016; AAOS: Board or committee member; American Association of Hip and Knee Surgeons: Board or committee member; JayPee: Publishing royalties, financial or material support; Journal of Arthroplasty: Editorial or governing board; Journal of the American Academy of Orthopaedic Surgeons: Editorial or governing board; Link Orthopaedics: Paid consultant; Stryker: Paid consultant; Zimmer: IP royalties; Paid consultant

David Christopher Ayers, MD Submitted on: 05/02/2016; AAOS: Board or committee member; American Orthopaedic Association: Board or committee member; Journal of Bone and Joint Surgery - American: Editorial or governing board

David Backstein, MD Submitted on: 11/28/2016; Clinical Orthopaedics and Related Research: Editorial or governing board; Intellijoint Orthopaedics: Stock or stock Options; Journal of Arthroplasty: Editorial or governing board; Micropor Orthopaedics: IP royalties; Paid consultant; Paid presenter or speaker; Surgical Services Inc: Research support; Zimmer: Paid consultant; Paid presenter or speaker

C Lowry Barnes, MD Submitted on: 10/10/2016; American Association of Hip and Knee Surgeons: Board or committee member; AR Orthopaedic Society: Board or committee member; Clinical Orthopaedics and Related Research: Editorial or governing board; ConforMIS: Research support; DJO: IP royalties; HealthTrust: Paid consultant; HipKnee Arkansas Foundation: Board or committee member; Journal of Arthroplasty: Editorial or governing board; JSOA: Editorial or governing board; Livena: Stock or stock Options; Medtronic: IP royalties; Paid consultant; Mid American Orthopaedic Association: Board or committee member; None: Unpaid consultant; Responsive Orthopaedics: Stock or stock Options; Responsive Risk Solutions: Paid consultant; Stock or stock Options; Southern Orthopaedic Association: Board or committee member; Zimmer: IP royalties; Paid consultant

Robert L Barrack, MD Submitted on: 10/04/2016; Biomet: Research support
Hip Society: Board or committee member; Journal of Bone and Joint Surgery - American: Editorial or governing board; Journal of Bone and Joint Surgery - British: Editorial or governing board; Knee Society: Board or committee member; Medical Compression Systems: Research support; National Institutes of Health (NIAMS & NICHD): Research support; Smith & Nephew: Research support; Stryker: IP royalties; Other financial or material support; Paid consultant; Research support; The McGraw-Hill Companies Inc: Publishing royalties, financial or material support; Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support; Wright Medical Technology, Inc.: Research support

Daniel J Berry, MD Submitted on: 04/27/2016; American Joint Replacement Registry: Board or committee member; DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Research support; Elsevier: Publishing royalties, financial or material support; Hip Society: Board or committee member; International Hip Society: Board or committee member; Journal of Bone and Joint Surgery - American: Editorial or governing board; Mayo Clinic Board of Governors: Board or committee member; Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Joseph A Bosco, III MD Submitted on: 10/03/2016; Association of Professionals in Infection Control (APIC): Board or committee member; Bulletin of the Hospital for Joint Diseases: Editorial or governing board; Genovel: IP royalties; Paid consultant; Stock or stock Options; Journal of Bone and Joint Surgery - American: Editorial or governing board; Labrador healthcare: Paid consultant; Medtronic: Paid consultant; Pacira: Paid presenter or speaker; Surgical directions consulting: Paid consultant; The Orthopedic Learning Center: Board or committee member

Kevin J. Bozic, MD: Submitted on 10/25/2016; American Joint Replacement Registry: Board or committee member; Centers for Medicare Services: Paid consultant; Harvard Business School: Paid consultant.

John J Callaghan, MD Submitted on: 10/17/2016; DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; International Hip Society: Board or committee member; Journal of Arthroplasty: Editorial or governing board; Journal of Arthroplasty (Deputy Editor): Publishing royalties, financial or material support; Knee Society: Board or committee member; Orthopaedic Research and Education Foundation: Board or committee member; Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Henry D Clarke, MD Submitted on: 01/19/2017; AAOS: Board or committee member; Association of Bone and Joint Surgeons: Board or committee member; Biomet: IP royalties; Paid consultant; ConforMIS: IP royalties; Paid consultant; Unpaid consultant; ICUR: Board or committee member; Journal of Arthroplasty: Editorial or governing board; Journal of the American Academy of Orthopaedic Surgeons: Editorial or governing board; Publishing royalties, financial or material support; Knee: Editorial or

95
governing board; Knee Society: Board or committee member; Smith & Nephew: Paid consultant; Paid presenter or speaker; Stryker: Research support; VIDACARE: Research support; Zimmer: IP royalties; Paid consultant

Clifford W Colwell Jr, MD Submitted on: 05/26/2016; Clinical Orthopaedics and Related Research: Editorial or governing board; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Editorial or governing board; Medical Compression Systems, Ltd.: Paid consultant; Scripps Institutional Review Board: Research support

Craig J Della Valle, MD Submitted on: 10/06/2016; American Association of Hip and Knee Surgeons: Board or committee member; Arthritis Foundation: Board or committee member; Biomet: IP royalties; Paid consultant; Research support; CD Diagnostics: Stock or stock Options; 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; 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

Douglas A Dennis, MD Submitted on: 10/05/2016; Clinical Orthopaedics and Related Research: Editorial or governing board; DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Paid presenter or speaker; DePuy, A Johnson & Johnson Company, Porter Adventist Hospital: Research support; Innomed: IP royalties; Joint Vue: Stock or stock Options; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Editorial or governing board; Orthopedics Today: Editorial or governing board; Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

Jesper Fabrin, MD (This individual reported nothing to disclose); Submitted on: 05/31/2016

Mark P Figgle, MD Submitted on: 10/03/2016; Knee Society: Board or committee member; Lima: IP royalties; Mekanika: Stock or stock Options

Kevin L Garvin, MD Submitted on: 01/30/2017; AAOS: Board or committee member; American Orthopaedic Association: Board or committee member; Hip Society: Board or committee member; Wolters Kluwer Health - Lippincott Williams & Wilkins: Editorial or governing board

William L Griffin, MD Submitted on: 10/03/2016; American Association of Hip and Knee Surgeons: Board or committee member; DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Paid presenter or speaker; Research support; Journal of Arthroplasty, CORR: Editorial or governing board; Knee Society, AAOS: Board or committee member; Zimmer: Research support

Fares Sami Haddad, FRCS Submitted on: 10/05/2016; Annals of the Royal College of Surgeons England: Editorial or governing board; Bone and Joint Journal: Editorial or governing board; corin: IP royalties; Journal of Arthroplasty: Editorial or governing board; Matortho: IP royalties; Orthopedics Today: Editorial or governing board; Smith & Nephew: IP royalties; Paid consultant; Research support; Stryker: IP royalties; Paid consultant

Arlen D Hanssen, MD Submitted on: 04/07/2016; Elsevier: Publishing royalties, financial or material support; International Congress for Joint Reconstruction (ICJR): Board or committee member; Stryker: IP royalties

William L Healy, MD (Newton, MA) (This individual reported nothing to disclose); Submitted on: 01/19/2017

Stephen J Incavo, MD Submitted on: 11/30/2016; Innomed: IP royalties; Journal of Arthroplasty: Editorial or governing board; Knee Society: Board or committee member; Kyocera: IP royalties; Nimbic Systems: Stock or stock Options; Osteoremedies: IP royalties; Smith & Nephew: IP royalties; Wright Medical Technology, Inc.: IP royalties; Zimmer: IP royalties; Paid consultant

Richard Iorio, MD Submitted on: 12/19/2016; American Association of Hip and Knee Surgeons: Board or committee member; Bioventis: Research support; Clinical Orthopaedics and Related Research: Editorial or governing board; DJ Orthopaedics: Paid consultant; Ferring Pharmaceuticals: Research support; Hip Society: Board or committee member; JBJS Reviews: Editorial or governing board; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Editorial or governing board; Journal of the American Academy of Orthopaedic Surgeons: Editorial or governing board; Knee Society: Board or committee member; MCS ActiveCare: Paid consultant; Stock or stock Options; Medtronic: Paid consultant; Muve Health: Paid consultant; Stock or stock Options; Orthofix, Inc.: Research support; Orthosensor: Research support; Pacira: Paid consultant; Research support; URX Mobile: Stock or stock Options; Vericel: Research support; Wellbe: Stock or stock Options

William A Jiranek, MD Submitted on: 04/12/2016; American Association of Hip and Knee Surgeons: Board or committee
member; Cayenne Medical: Paid consultant; DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Research support; Johnson & Johnson: Stock or stock Options; Lifenet Health, Inc.: Board or committee member; OLC Orthopaedic Learning Center: Board or committee member; Stryker: Research support

Andreas Kappel, MD (This individual reported nothing to disclose); Submitted on: 05/31/2016

Jun-Shik Kim, MD (This individual reported nothing to disclose); Submitted on: 04/15/2016

Young-Hoo Kim, MD (This individual reported nothing to disclose); Submitted on: 12/20/2016

Matthew J Kraay, MD Submitted on: 10/03/2016; AAOS: Board or committee member; American Joint Replacement Registry: Board or committee member

Per Wagner Kristensen, MD (This individual reported nothing to disclose); Submitted on: 05/26/2016

Paul F Lachiewicz, MD Submitted on: 10/03/2016; Gerson Lehman Group: Paid consultant; Guidepoint Global Advisors: Paid consultant; Innomed: IP royalties; Journal of Arthroplasty: Editorial or governing board; Journal of Surgical Orthopaedic Advances: Editorial or governing board; Mallinckrodt (formerly Cadence): Paid presenter or speaker; Pacira: Paid consultant; Paid presenter or speaker; Zimmer: Research support

Carlos J Lavernia, MD Submitted on: 05/04/2016; Biomet: Paid consultant; Florida Orthopaedic Society: Board or committee member; Johnson & Johnson: Stock or stock Options; Journal of Arthroplasty: Editorial or governing board; MAKO SURGICAL/STRYKER: IP royalties; Stryker: Stock or stock Options; Symmetry Medical (Telcomet): Stock or stock Options; Wright Medical Technology, Inc.: Stock or stock Options; Zimmer: Paid consultant; Stock or stock Options

David G Lewallen, MD Submitted on: 10/10/2016; Acuitive Technologies: Paid consultant; Stock or stock Options; American Joint Replacement Registry: Board or committee member; Ketai Medical Devices: Stock or stock Options; Unpaid consultant; Link Orthopaedics: Paid consultant; Mako/Stryker: IP royalties; Orthopaedic Research and Education Foundation: Board or committee member; Pipeline: IP royalties; Zimmer Biomet: IP royalties; Paid consultant

Jay R Lieberman, MD Submitted on: 10/05/2016; AAOS: Board or committee member
American Association of Hip and Knee Surgeons: Board or committee member; DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Hip Innovation Technology: Stock or stock Options; Musculoskeletal Transplant Foundation: Board or committee member; Saunders/Mosby-Elsevier: Publishing royalties, financial or material support; Western Orthopaedic Association: Board or committee member

Shari Ling, MD (This individual reported nothing to disclose); Submitted on: 05/02/2016

Adolph V Lombardi Jr, MD Submitted on: 10/10/2016; Clinical Orthopaedics and Related Research: Editorial or governing board; Hip Society: Board or committee member; Innomed: IP royalties; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Editorial or governing board; Journal of Orthopaedics and Traumatology: Editorial or governing board; Journal of the American Academy of Orthopaedic Surgeons: Editorial or governing board; Kene: Editorial or governing board; Knee Society: Board or committee member; Mount Carmel Education Center at New Albany: Board or committee member; Operation Walk USA: Board or committee member; Orthosensor: IP royalties; Paid consultant; Pacira Pharmaceuticals, Inc.: Paid consultant; Research support; SPR Therapeutics, LLC: Research support; Stock or stock Options; Surgical Technology International: Editorial or governing board; Zimmer Biomet: IP royalties; Paid consultant; Research support

Frank Madsen, MD (This individual reported nothing to disclose); Submitted on: 05/31/2016

Steven J MacDonald, MD Submitted on: 10/11/2016; DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Research support; Hip Innovations Technology, JointVue: Stock or stock Options; Smith & Nephew: Research support; Stryker: Research support

David Jacob Mayman, MD Submitted on: 05/01/2016; Knee Society: Board or committee member; OrthAlign: Stock or stock Options; Smith & Nephew: Paid consultant; Paid presenter or speaker

Patrick C McCulloch, MD Submitted on: 10/04/2016; Journal of Knee Surgery: Editorial or governing board; Orthobullets.com: Editorial or governing board

Grant Austin Moore (This individual reported nothing to disclose); Submitted on: 06/19/2016
Douglas Naudie, MD, FRCSC Submitted on: 05/30/2016; DePuy, A Johnson & Johnson Company; Other financial or material support; Smith & Nephew: IP royalties; Other financial or material support; Paid consultant; Paid presenter or speaker; Stryker: Other financial or material support; Paid consultant; Paid presenter or speaker

Philip C Noble, PhD Submitted on: 10/19/2016; CeramTech: Research support; DJ Orthopaedics: Research support; International Society for Technology in Arthroplasty: Board or committee member; Joint View, LLC: Stock or stock Options; Journal of Arthroplasty: Editorial or governing board; Journal of Hip Preservation Surgery: Editorial or governing board; Knee Society: Board or committee member Microport: Research support; Musculoskeletal Transplant Foundation: Other financial or material support; Smith & Nephew: Research support; Springer: Publishing royalties, financial or material support; Stryker: IP royalties; Zimmer: IP royalties; Paid consultant; Research support

Anders Odgaard, DMed, FRCS (Ortho), MD (Denmark) Submitted on: 05/30/2016; Biomet: Paid presenter or speaker; Research support; Danish Knee Arthroplasty Register: Board or committee member; DePuy, A Johnson & Johnson Company: Paid presenter or speaker; Stryker: Research support

Mark W Pagnano, MD Submitted on: 04/04/2016; DePuy, A Johnson & Johnson Company: IP royalties; Hip Society: Board or committee member; Knee Society: Board or committee member; Pacira: Paid consultant; Stryker: IP royalties

Jangwon Park, MD, MSc (This individual reported nothing to disclose); Submitted on: 04/20/2016

Javad Parvizi, MD, FRCS Submitted on: 01/19/2017; 3M: Research support; Aesculap/B.Braun: Research support; Alphaneon: Stock or stock Options; AO Spine: Research support; Biomet: Research support; CD Diagnostics: Stock or stock Options; Cempra: Research support; CeramTec: Paid consultant; Research support; Ceribel: Stock or stock Options; ConvaTec: Paid consultant; Corentec: Publishing royalties, financial or material support; Stock or stock Options; Cross Current Business Intelligence: Stock or stock Options; Datatrace: Publishing royalties, financial or material support; DePuy, A Johnson & Johnson Company: Research support; Eastern Orthopaedic Association: Board or committee member; Elsevier: Publishing royalties, financial or material support; Ethicon: Paid consultant; Hip Innovation Technology: Stock or stock Options; Integra: Research support; Intellijoint: Stock or stock Options; Invisible Sentinel: Stock or stock Options; Jaypee Publishers: Publishing royalties, financial or material support; Joint Purification Systems: Stock or stock Options; Journal of Arthroplasty: Editorial or governing board; Journal of Bone and Joint Surgery - American: Editorial or governing board; Journal of Bone and Joint Surgery - British: Editorial or governing board; MedAp: Stock or stock Options; MicroGenDx: Stock or stock Options; Muller Foundation: Board or committee member; Myoscience: Research support; National Institutes of Health (NIAMS & NICHD): Research support; NDRI: Research support; Novartis: Research support; OREF: Research support; Orthospace: Research support; Parvizi Surgical Innovations: Stock or stock Options; Pfizer: Research support; Physician Recommended Nutriceuticals: Stock or stock Options; Rotation Medical: Research support; Simplify Medical: Research support; SLACK Incorporated: Publishing royalties, financial or material support; Smith & Nephew: Research support; StelKast: Research support; Stryker: Research support; Synthes: Research support; TissueGene: Paid consultant; Research support; Tomier: Research support; Wolters Kluwer Health – Lippincott; Williams & Wilkins: Publishing royalties, financial or material support; Zimmer: Paid consultant; Research support

Christopher L Peters, MD Submitted on: 11/08/2016; American Association of Hip and Knee Surgeons: Board or committee member; Biomet: IP royalties; Paid consultant; Paid presenter or speaker; Research support; CoNexions Medical: Stock or stock Options; Journal of Arthroplasty: Editorial or governing board; Joint of Hip Preservation: Editorial or governing board; Knee Society: Board or committee member; Muve Health: Stock or stock Options

Rocco P Pitto, MD, PhD Submitted on: 10/19/2016; Association of Bone and Joint Surgeons: Board or committee member; Ceramtec: Research support

Michael D Ries, MD Submitted on: 04/14/2016; Foundation for the Advancement of Research in Medicine: Board or committee member; OrthAlign: Stock or stock Options; Smith & Nephew: IP royalties; Paid consultant; Stryker: IP royalties; Paid consultant

Harry E Rubash, MD Submitted on: 10/13/2016; Ceramtec: IP royalties; Flexion: Paid consultant; Hip Society: Board or committee member; Orthopaedic Technology Group: Stock or stock Options; Pacira: Paid consultant; Stryker: IP royalties; Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support

W Norman Scott, MD Submitted on: 11/02/2016; Author, Surgery of the Knee 5th Edition, Elsevier: Publishing royalties, financial or material support; Author, Surgery of the Knee 6th Edition, Elsevier: Publishing royalties, financial or material support; OrthoDevelopment Medical Advisor to Board of Directors: Paid consultant; President & CEO ICJR (International Congress for Joint Reconstruction): Board or committee member; Zimmer Past Royalty Bearing Designer: IP royalties
Giles R Scuderi, MD Submitted on: 04/04/2016; Convatec: Paid presenter or speaker; Medtronic: Paid consultant; Paid presenter or speaker; MERZ Pharmaceutical: Paid consultant; Operation Walk USA: Board or committee member; Pacira: Paid consultant; Paid presenter or speaker; Research support; SpringerElsevierThiemeWorld Scientific: Publishing royalties, financial or material support; Zimmer: IP royalties; Paid consultant; Paid presenter or speaker

Thomas P Sculco, MD Submitted on: 04/28/2016; American Journal of Orthopedics: Editorial or governing board; Exactech, Inc: IP royalties; Knee Society: Board or committee member

Rafael Jose Sierra, MD Submitted on: 10/07/2016; American Association of Hip and Knee Surgeons: Board or committee member; Biomet: IP royalties; Paid consultant; Paid presenter or speaker; DePuy, A Johnson & Johnson Company: Research support; Journal of Arthroplasty: Editorial or governing board; Link Orthopaedics: Paid consultant; Stryker, Biomet: Research support; Zimmer: Research support

Mark J Spangehl, MD Submitted on: 10/03/2016; Arthroplasty Today: Editorial or governing board; DePuy, A Johnson & Johnson Company: Research support; Journal of Arthroplasty: Editorial or governing board; Stryker: Research support; Vidacare: Research support

Bryan Donald Springer, MD Submitted on: 12/05/2016; 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; Osteoremedies: Paid consultant; PixarBio: Stock or stock Options; Stryker: IP royalties; Paid consultant

Robert T Trousdale, MD Submitted on: 10/03/2016; American Association of Hip and Knee Surgeons: Board or committee member; DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Hip Society: Board or committee member; Journal of Arthroplasty: Editorial or governing board; Knee Society: Board or committee member; Medtronic: IP royalties

Simon Young, MD, FRACS Submitted on: 10/14/2016; Arthrex, Inc: Paid presenter or speaker; DePuy, A Johnson & Johnson Company: Paid presenter or speaker; Stryker: Paid consultant; Paid presenter or speaker; Research support; Surgical Solutions: Stock or stock Options; Vidacare: Research support

Mei Zhang, MD (This individual reported nothing to disclose); Submitted on: 08/17/2016

Staff
Olga Foley (This individual reported nothing to disclose); Submitted on: 01/30/2017
Austin Lugar (This individual reported nothing to disclose); Submitted on: 10/18/2016

The Knee Society
9400 W. Higgins Road, Suite 500
Rosemont, IL 60018-4976
Phone: (847)698-1632
Fax: (847)823-0536
Email: knee@aaos.org
Website: www.kneesociety.org

American Association of Hip and Knee Surgeons
9400 W. Higgins Rd., Suite 230
Rosemont, IL 60018-4976
Phone: (847)698-1200
Fax: (847)698-0704
Email: helpdesk@aahks.org
Website: www.aahks.org

Please complete the evaluation online at: https://www.surveymonkey.com/r/KSSD2017 or use the QR Code to access.