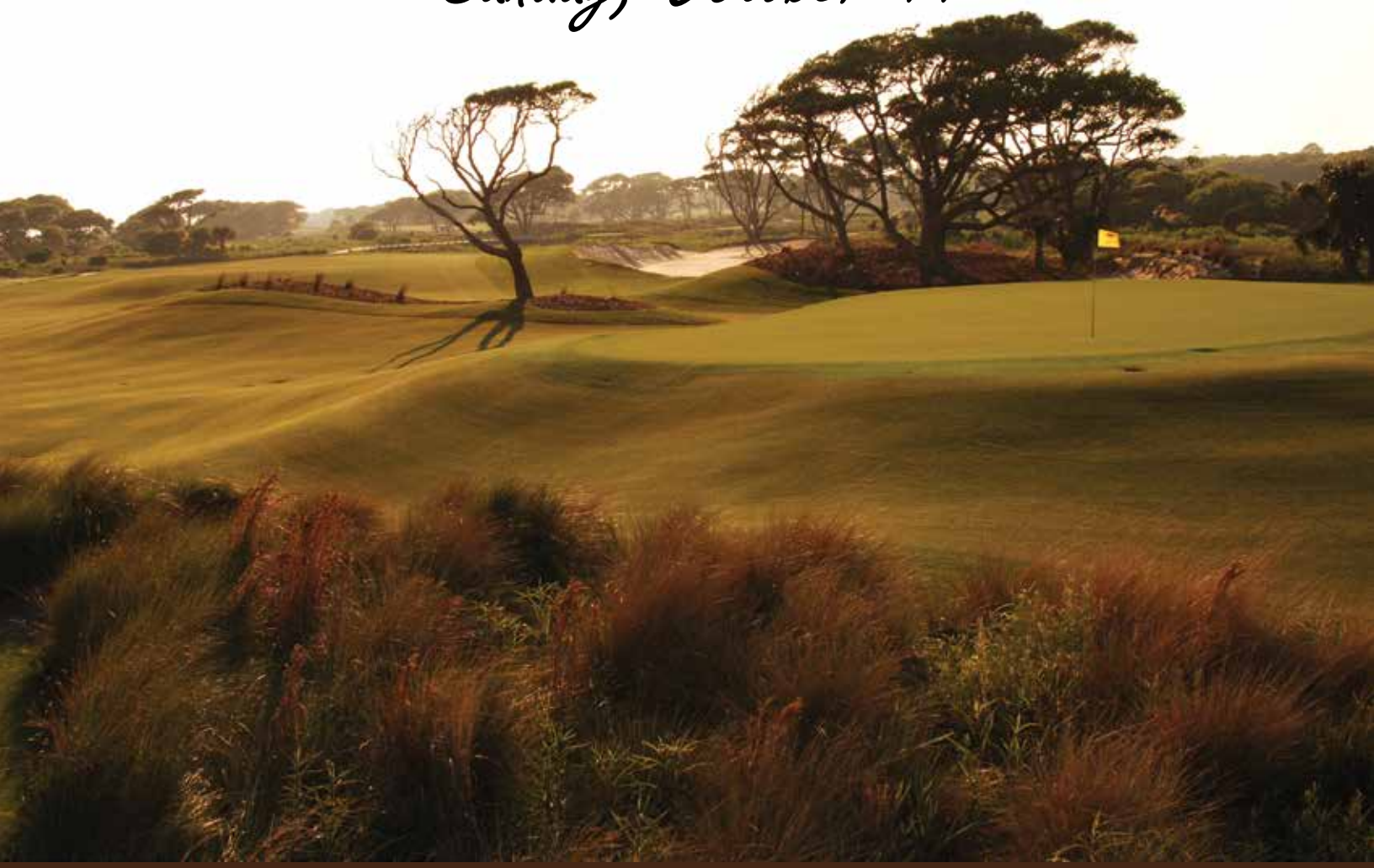
# North Carolina Orthopaedic Association

# 2015 Annual Meeting

## Reconstruction

## Sunday, October 11



**October 9-11, 2015 • Kiawah Island Golf Resort**

Kiawah Island, South Carolina

This continuing medical education activity is jointly provided by the NCOA and the Southern Regional Area Health Education Center

TOTAL JOINT ORTHOPEDICS

# STEM EXTENSIONS

- 25, 50, 100, 150 straight stems
- Cemented use only
- Tapered Design
- Threaded Baseplate Attachment

Less is More.

TOTAL JOINT ORTHOPEDICS

# KLASSIC® KNEE TIBIAL INSERT DESIGN

- Deep-dished Ultra PS and Standard CR/Congruent inserts available.
- No box cut for PCL sacrificing procedure conserves bone.
- Locking tibial set screw reduces backside wear.
- The primary locking mechanism of the insert is the set screw.
- Use 3.5mm hex screwdriver for locking screw.
- The anterior build-up on the Ultra PS insert in 10.5mm.
- The anterior build-up on the CR Congruent insert is 4mm.
- Articulating thickness of 10mm poly insert is 6.5mm.
- Posterior relief for maximum flexion.
- Consistent poly thickness to peripheral edges.

Less is More.

TOTAL JOINT ORTHOPEDICS

# KLASSIC® KNEE TIBIAL COMPONENT SIZING

- (6) sizes
- Baseplate thickness is 3.5mm.
- Interchangeability with femur is 2 up and 2 down.
- The capture slot thickness of the universal cut block is 0.50” (1.27mm).

Less is More.

TOTAL JOINT ORTHOPEDICS

# KLASSIC® KNEE TIBIAL COMPONENT DESIGN

- Symmetric design with conforming M/L edges.
- The tibial keel has a posterior slope of 4˚.
- The length of the tibial boss is 25mm without dome plug (35mm with plug).
- The diameter of the peripheral pegs is 4mm.
- The resection level is 8mm when pins are placed through the “frog eyes” of the universal cut block.
- The locking set screw is packaged with the tibial component.
- The tibial boss is 13mm in diameter.

Less is More.

# CoCr Ongrowth

Axial CT of TKA showing bone ongrowth to the tibial keel/boss

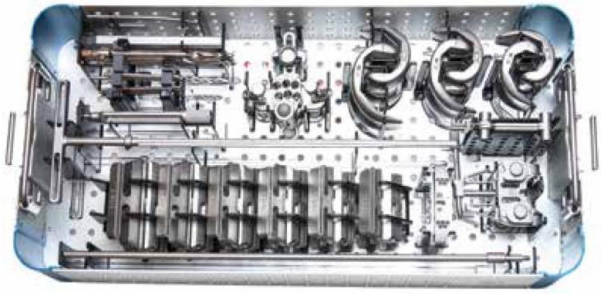
Supports the use selective surface cementing technique

3 instrument trays

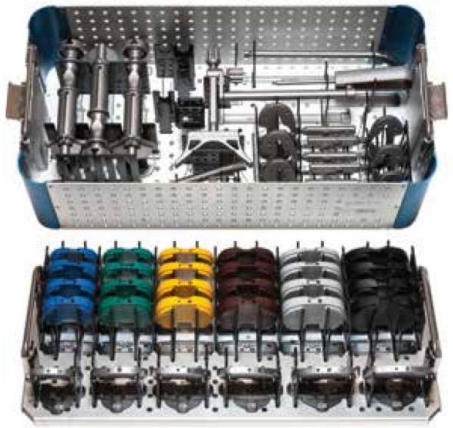
Single or Bilateral tka

One connect for all drills/reamers for lug holes/patella pegs etc

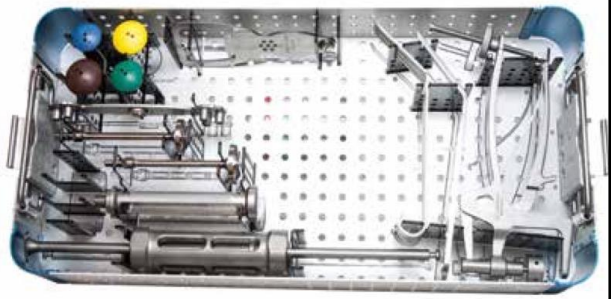
One universal cutting block for distal femur and proximal tibia



*Femoral Preparation Instrumentation*



*Tibial Preparation Instrumentation*



*Patella/Miscellaneous Preparation Instrumentation*

**KLASSIC™ KNEE SYSTEM**

**Knee Instrumentation**

Includes three cases
and all instrumentation
Catalog Number: 2500.00.000

My OR Table

Gender Setup

One working table

"Almost" scrub nurse resistant

Minimal disposables

- one blade
- smooth pins

# My early experience

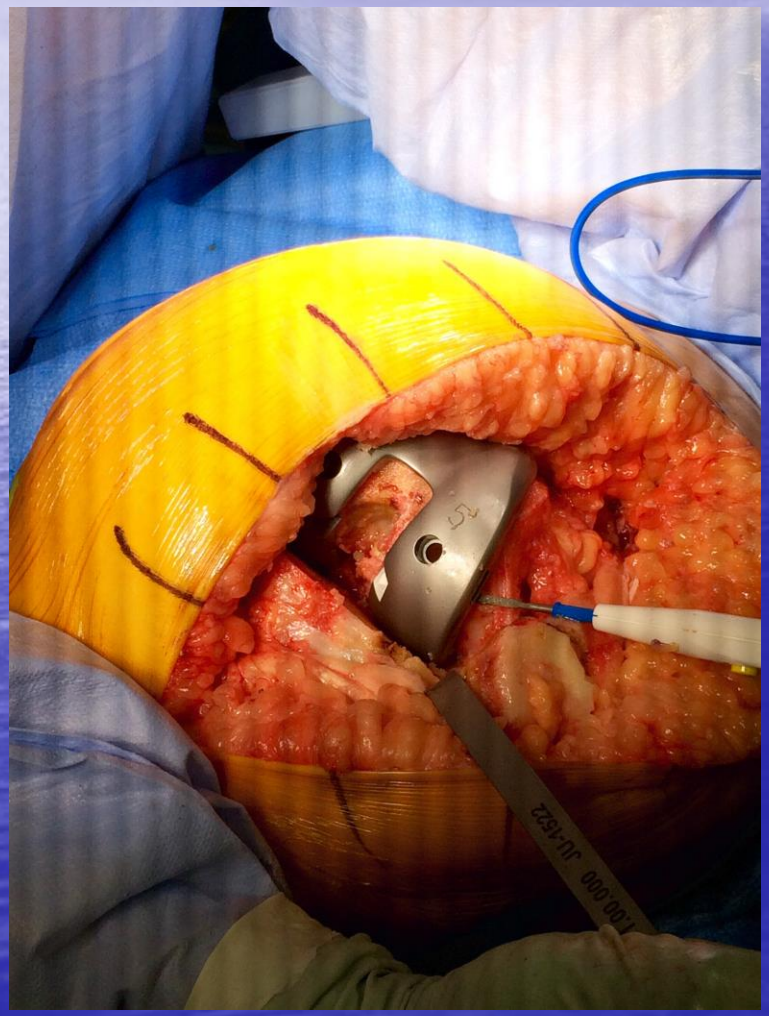
Started in September 2014

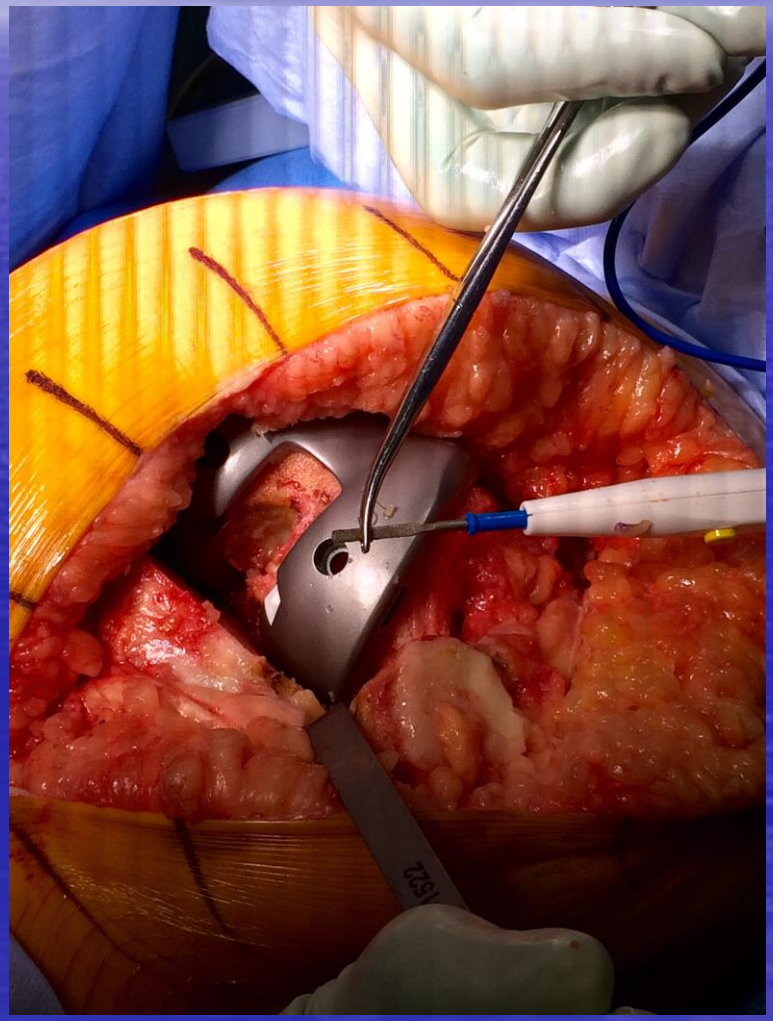
Implanted 140

3 reoperations

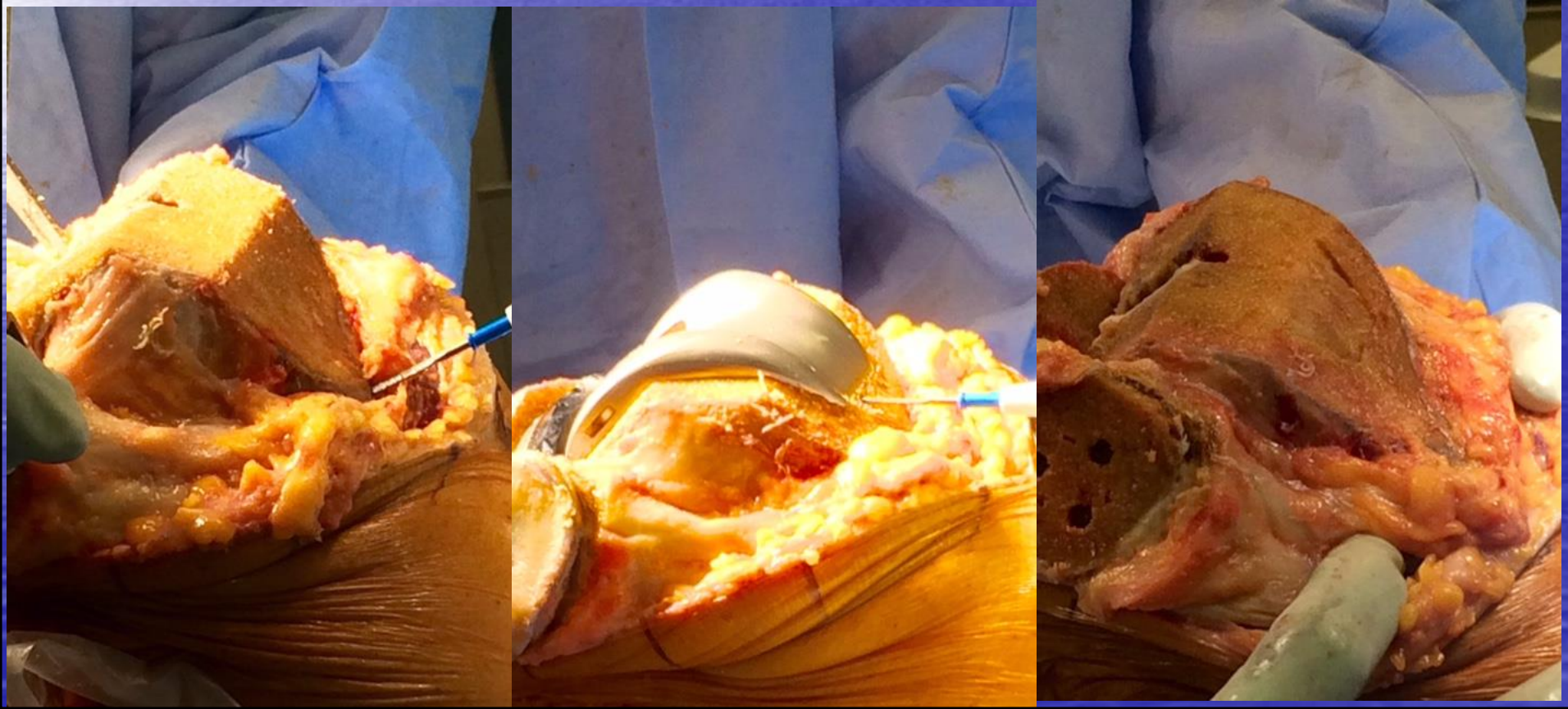
- 2 for traumatic dehiscence for mechanical fall
- 1 for patella instability

# Learning Curve





# Learning Curve



# Design Response

Reduced M/L dimensions for sizes 2-4

Size 7 femur

ORTHO WILMINGTON

# Patella Instability

56 yo male with OA knee

PMHX- Autoimmune necrotizing myopathy

- TX cellcept, prednisone, and IVIG
- Wheelchair/minimal ambulation

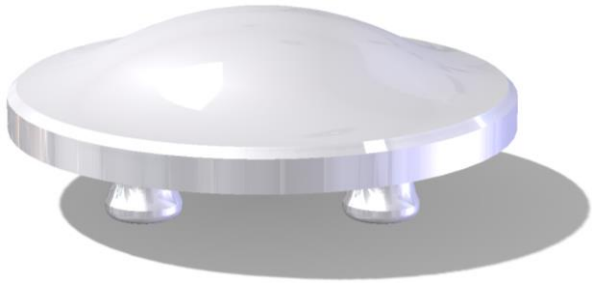
ORTHO WILMINGTON


ORTHO WILMINGTON


movie.MOV
ORTHO WILMINGTON

TOTAL JOINT ORTHOPEDICS

# SOMBRERO



- 4 sizes, constant thickness
- Dimensions – 7mm at Apex, 3mm at Rim
- Same 4 diameters as the domed patella

| SOMBRERO PATELLA SIZING (mm) | | |
|---|---|---|
| SIZE | DIAMETER | THICKNESS |
| 1 | 28 | 7 |
| 2 | 31 | 7 |
| 3 | 34 | 7 |
| 4 | 37 | 7 |

Less is More.

# Operation walk

Started in 1995

One TKA is donated to their cause with every 10 knees implanted

Currently in Costa Rica this week for 70 joint replacements

Wake Forest®
School of Medicine

# Decreased Range of Motion Following Total Knee Arthroplasty Is Predicted by the Tampa Scale of Kinesiophobia

Brown ML, Plate JF, Von Thaer S, Fino NF, Smith BP, Seyler TM, Lang JE

Author disclosure is in the Final Program.

The authors have no conflicts

# Range of Motion After TKA is Important

ROM associated with:

- Pain relief
- Function
- Patient satisfaction


Risk Factors for Decreased ROM following TKA:

- Decreased preoperative ROM (Anouchi CORR 1996; Sancheti Indian J Orthop 2013)
- Previous knee surgery (Yercan Knee 2006; Scranton J Arthroplasy 2001)
- Diabetes (Yercan Knee 2006; Scranton J Arthroplasy 2001)
- Component malpositioning
- Non-compliance with physical therapy (Meier J Orthop Sports Phys Ther 2008)

# Patient Psychology Influences Outcomes of Orthopaedic Surgery

- Fear of movement associated with increased pain and disability following spine surgery (Archer The Spine Journal 2014)

- Psychological factors associated with return to sport following ACL reconstruction (Webster Phys Ther Sport 2008)

- Lower mental component scores less likely to improve physically after TKA
  (Heck CORR 1998; Brander CORR 2007, Franklin CORR 2008)

# Fear-Avoidance Cognitive Behavioral Model:

## A Framework to Understand Chronic Pain Syndromes

Injury

**Pain correctly perceived as non-threatening allows:**

- Rehabilitation
- Gradual return to normal activity


**Pain incorrectly perceived as threatening leads to:**

- Kinesiophobia, a pain-related fear of movement
- Cycle of pain and disuse
- Chronic pain and physical dysfunction

Lethem J Behav Res Ther 1983; Vlaeyen Pain 1995

# Tampa Scale of Kinesiophobia (TSK)

- 17-item questionnaire
- 4 point Likert scale
- 4 negatively worded, reversed scored questions
- TSK scores range from 17 to 68
- scores >39 indicate a high fear of movement
- Validated instrument

Modified Tampa Scale for Kinesiophobia

| | Strongly Disagree | Disagree | Agree | Strongly Agree |
|---|---|---|---|---|
| 1. I'm afraid that I might injure myself if I exercise | 1 | 2 | 3 | 4 |
| 2. If I were to try to overcome it, my pain would increase | 1 | 2 | 3 | 4 |
| 3. My body is telling me I have something dangerously wrong | 1 | 2 | 3 | 4 |
| 4. My pain would probably be relieved if I were to exercise | 1 | 2 | 3 | 4 |
| 5. People aren't taking my medical condition seriously enough | 1 | 2 | 3 | 4 |
| 6. My condition has put my body at risk for the rest of my life | 1 | 2 | 3 | 4 |
| 7. Pain always means I have injured my body | 1 | 2 | 3 | 4 |
| 8. Just because something aggravates my pain does not mean it is dangerous | 1 | 2 | 3 | 4 |
| 9. I am afraid that I might injure myself accidentally | 1 | 2 | 3 | 4 |
| 10. Simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening | 1 | 2 | 3 | 4 |
| 11. I wouldn't have this much pain if there weren't something potentially dangerous going on in my body | 1 | 2 | 3 | 4 |
| 12. Although my condition is painful, I would be better off if I were physically active | 1 | 2 | 3 | 4 |
| 13. Pain lets me know when to stop exercising so that I don't injure myself | 1 | 2 | 3 | 4 |
| 14. It's really not safe for a person with a condition like mine to be physically active | 1 | 2 | 3 | 4 |
| 15. I can't do all the things normal people do because it's too easy for me to get injured | 1 | 2 | 3 | 4 |
| 16. Even though something is causing me a lot of pain, I don't think it's actually dangerous | 1 | 2 | 3 | 4 |
| 17. No one should have to exercise when he/she is in pain | 1 | 2 | 3 | 4 |

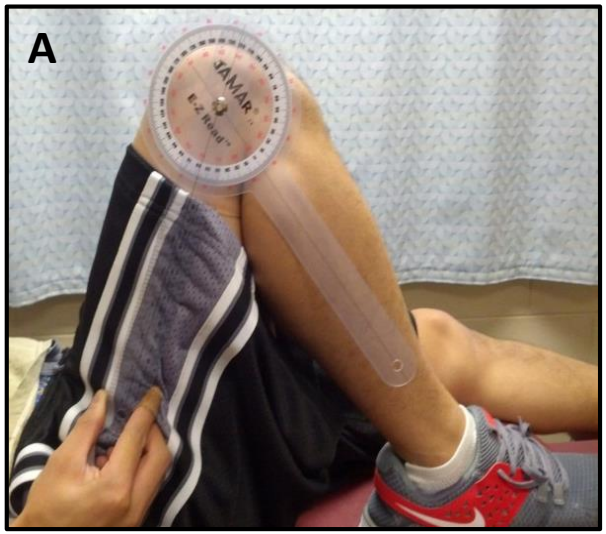
# Purpose

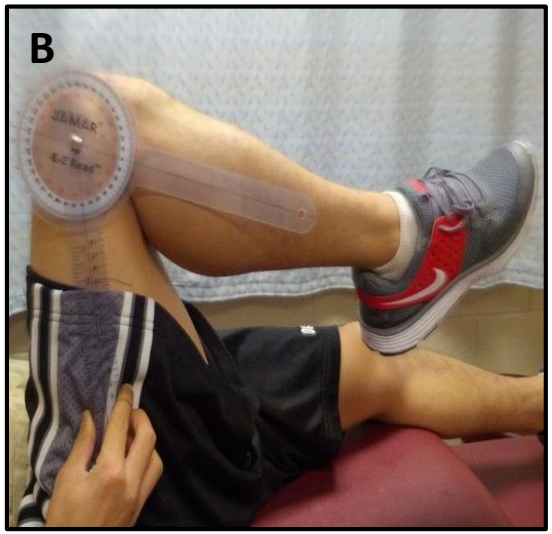
Hypothesis 1: A higher TSK score, which indicates more pain-related fear of movement, would correlate with decreased ROM after primary TKA.

Hypothesis 2: Biofeedback via showing patients a clinical photograph of their operated knee in maximum passive flexion would mitigate decreased ROM after TKA in patients with higher TSK scores.

# Methods

| Data Collection Timeline | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PreOp | PostOp [days] | | | | Outpatient Followup [weeks] | | | |
| | | 1 | 2 | 3 | 4 | 2 | 6 | 12 | 26 |
| **Knee Range of Motion** | X | BID | BID | BID | BID | X | X | X | X |
| **Clinical Photograph** | | | X | | | X | | | |
| **SF-12** | X | | | | | | X | | X |
| **Geriatric Depression Scale (GDS)** | X | | | | | | | | |
| **McGill Pain Score (MPS)** | X | | X | X | X | X | X | X | X |
| **Tampa Scale of Kinesiophobia (TSK)** | X | | X | X | X | X | X | X | X |





Statistical Analysis: A linear mixed model with random intercepts and slopes for time was used to detect any association between knee ROM and TSK or viewing the clinical photograph.

# Results

79 patients analyzed for correlation between TSK and knee ROM.

Subset of 60 patients included in biofeedback portion; 29 randomized to control group and 31 randomized to photograph group.

No significant differences in demographics or comorbidities between patients in control and photograph groups

| | Active Knee Flexion [deg] | | | Passive Knee Flexion [deg] | | | Physical Therapy [sessions] | | | Distance Walked [ft] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | SE | *P* value | β | SE | *P* value | β | SE | *P* value | β | SE | *P* value |
| **Age** | 0.07 | 0.20 | 0.72 | 0.13 | 0.21 | 0.55 | 0.07 | 0.15 | 0.66 | -3.45 | 1.69 | 0.13 |
| **Charlson Comorbidity Index (CCI)** | -2.03 | 1.55 | 0.19 | -0.07 | 1.71 | 0.97 | -1.21 | 1.07 | 0.34 | -19.92 | 12.45 | 0.21 |
| **Female sex** | -2.65 | 3.52 | 0.45 | -5.11 | 3.70 | 0.10 | -0.22 | 2.75 | 0.94 | -15.53 | 30.39 | 0.65 |
| **Tampa Scale of Kinesiophobia (TSK)** | -0.47 | 0.18 | 0.01 | -0.66 | 0.18 | <0.0005 | -0.10 | 0.18 | 0.62 | -0.46 | 2.04 | 0.83 |
| **Viewed Photo** | -1.21 | 3.22 | 0.71 | -0.20 | 3.39 | 0.95 | -0.79 | 2.41 | 0.76 | -10.19 | 27.45 | 0.74 |

1 point increase in TSK associated with:

- 0.47° decrease in active knee flexion after TKA
- 0.66° decrease in passive knee flexion after TKA

# Discussion

- Higher TSK scores predicted poorer functional outcome after TKA but no ROM data reported (Sullivan Pain 2009)
- TKA patients with kinesiophobia walked shorter distances in timed test, no difference length of stay, pROM, or pain (Doury-Panchout Eur J Phys Rehabil Med 2005)
- Significant association between increased Pain Catastrophizing Score (PCS) and poor outcome after TKA and trend towards poor outcome with higher TSK score (Riddle CORR 2010)

- Our data extends these findings and specifically highlights the association between increased TSK scores and decreased ROM following TKA.

# Conclusion

- The TSK may help arthroplasty surgeons identify patients at risk for decreased ROM
- Patients with kinesiophobia should be counseled regarding increased risk of decreased ROM
- Counseling protocols have shown success in helping improve outcomes following TKA in patients with Kinesiophobia (Naylor J Am Pain Soc 2002; Monticone Arch Phys Med Rehabil 2013)

# Thank You


# A prospective observational study of TKA compared to PKA with respect to outcome of pain and function scores compared to preoperative Pain and function: Predictors of outcome

Michael Le MD, Michael Berend MD, Keith Berend MD, and David Mauerhan MD

# Disclosures

- I have no disclosures for this talk
- **Mauerhan:** Board Member of American Association of Hip and Knee Surgeons, Paid consultant Biomet, Royalties from Biomet
- **K. Berend:** AAOS Board of Specialty Societies, Board Member of American Association of Hip and Knee Surgeons, CORR Editorial board, J of Arthroplasty Editorial board, JBJS Editorial board, Kinamed Research Support, Knee Society Board member, Orthpaedics Editorial board, Orthosensor Research support, Pacira Research Support, Reconstructive Review Editorial Board, Zimmer Biomet Royalties, Paid consultant, research support
- M. Berend: Board Member of American Association of Hip and Knee Surgeons, Biomet Royalties, Paid consultant, research support, Johnson and Johnson Research Support, Joint Replacement Surgeons of Indiana Research Foundation Research support, J of Arthroplasty Editorial Board, Orthalign Stock holder, Piedmont Ortho Board member, Stryker Research Support

# Introduction

- Estimated 719,000 TKA and 30,000 PKA performed each year.
- TKA Survivorship exceeds 90% at 15-20 years (1-3)
- PKA Survivorship exceeds 90% at 15-20 years (4-8)
  - Anteromedial arthritis
- Patients with TKA are dissatisfied up to 10-15% (9-11)
  - Continued pain, reduced function or failure to meet expectations
- PKA have a failure rate 2-3 times higher than TKA within the first 5 years (NZJR)
- Revision of PKA occurs 4-6 times higher than TKA at any Oxford Knee Score (12)

# Introduction

- Oxford Scores:
  - <26 Poor:  TKA 10% and PKA 60% revision rate (NZJR)
  - 34-48 Good to excellent:  4 times higher PKA revision than TKA (NZJR)
- 1/3 of PKA revision occurs within 1st year of index procedure (NZJR)
- Purpose:  Prospectively collect patient outcome scores of TKA and PKA then analyzing  factors such as Chronic pain and Psychiatric history that may affect outcomes

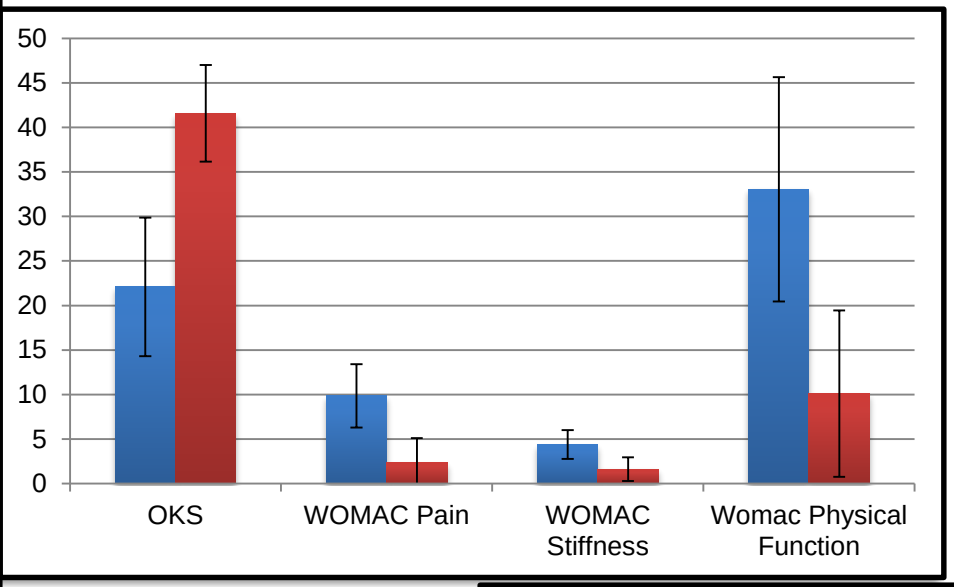
# Methods

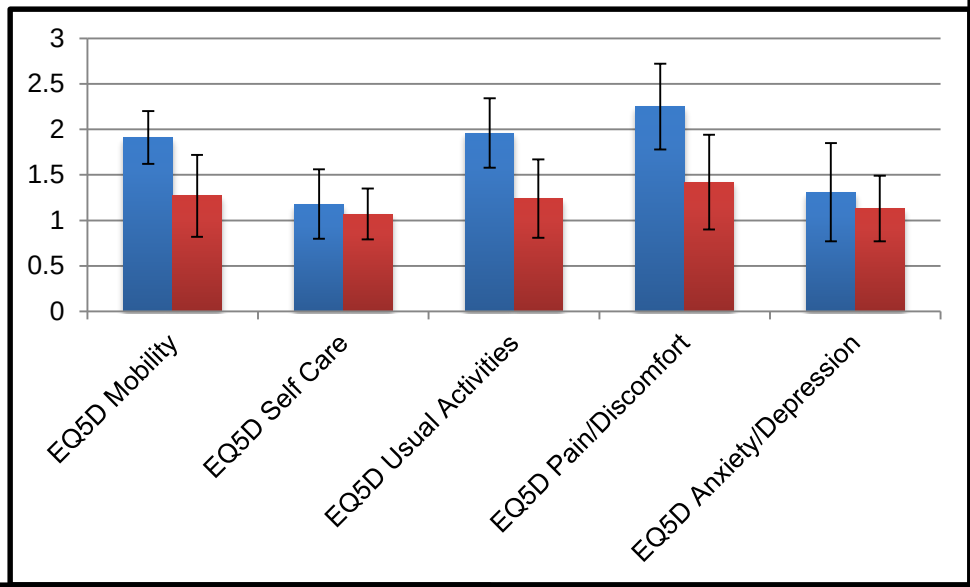
- Multicenter prospective observational study
  - CMC, Center for Hip and Knee Surgery (Mooresville, IN) and Joint Implant Surgeons (New Albany, OH)
- 182 Patients enrolled from April 2011 to May 2013.
- Indications:
  - TKA:  OA in 2 or 3 compartments of the knee
  - PKA:  anteromedial arthritis with intact ligamentous structures and benign lateral compartment
- Exclusions:
  - Patients with Inflammatory arthritis ( RA, SLE, AS)
  - Osteonecrosis:  spontaneous or steroid induced
- 76 TKA and 66 PKA (142)

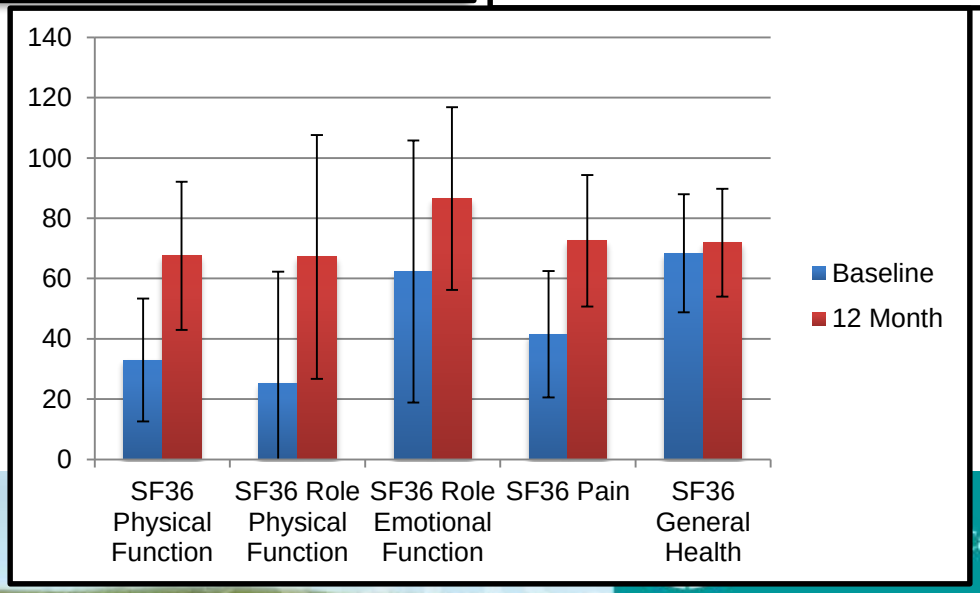
# Methods

- Outcome Measures:
  - Oxford Knee Sore
  - WOMAC
  - SF36
  - EQ5D
- Assessed Preoperative and 12 months post-operatively
- Statistical Analysis:
  - Wilcoxon signed-rank test
  - T-test

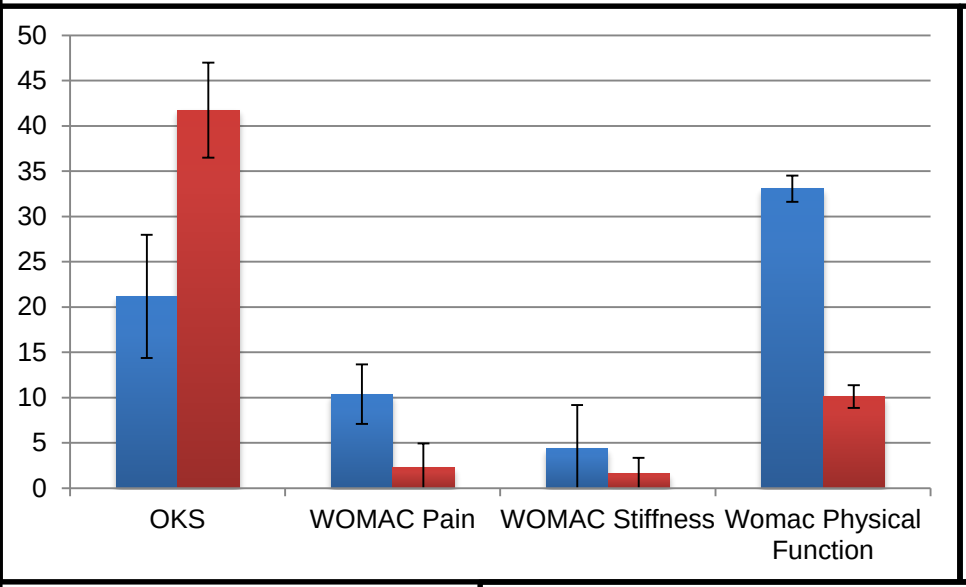
# All Patients

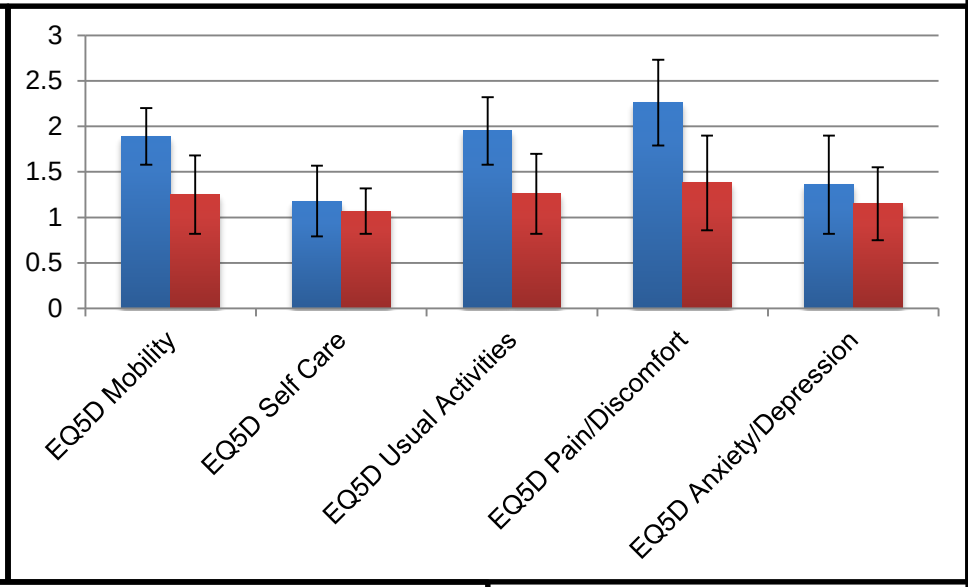


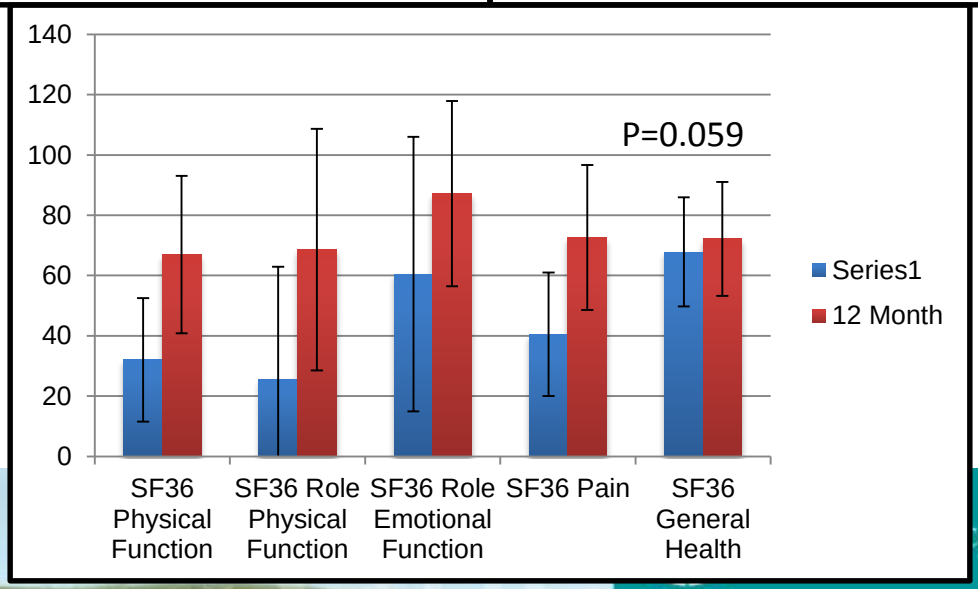



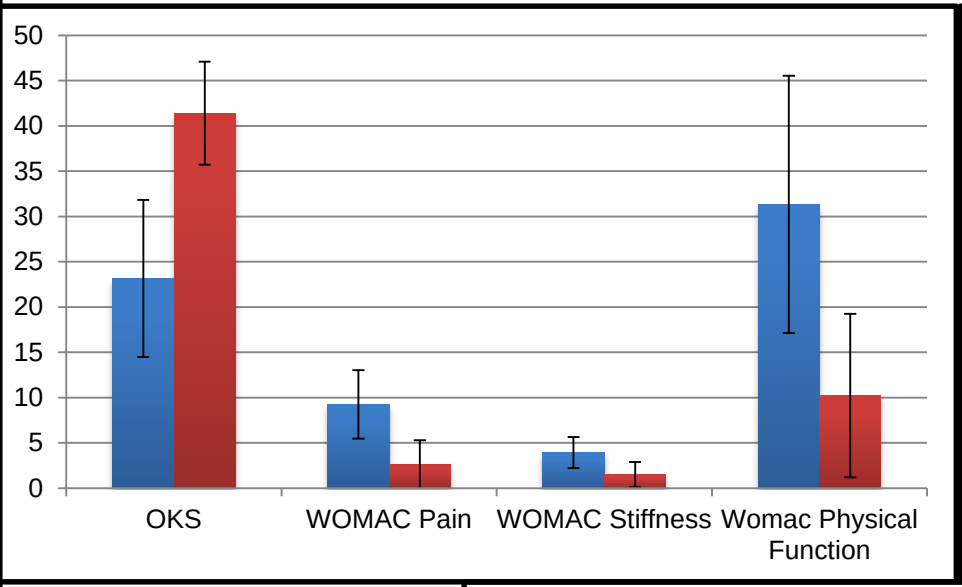
# TKA

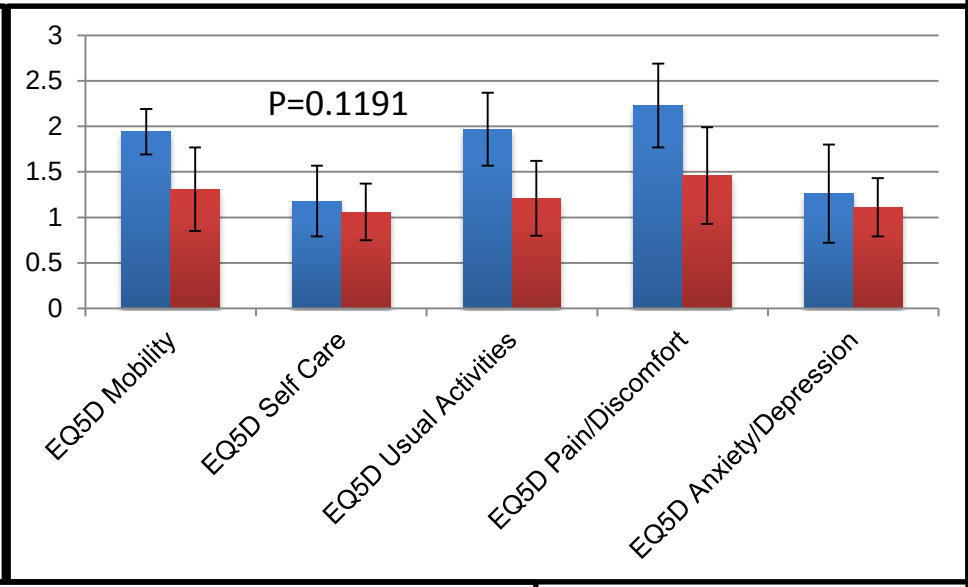

50
45
40
35
30
25
20
15
10
5
0
OKS
WOMAC Pain
WOMAC Stiffness
Womac Physical Function

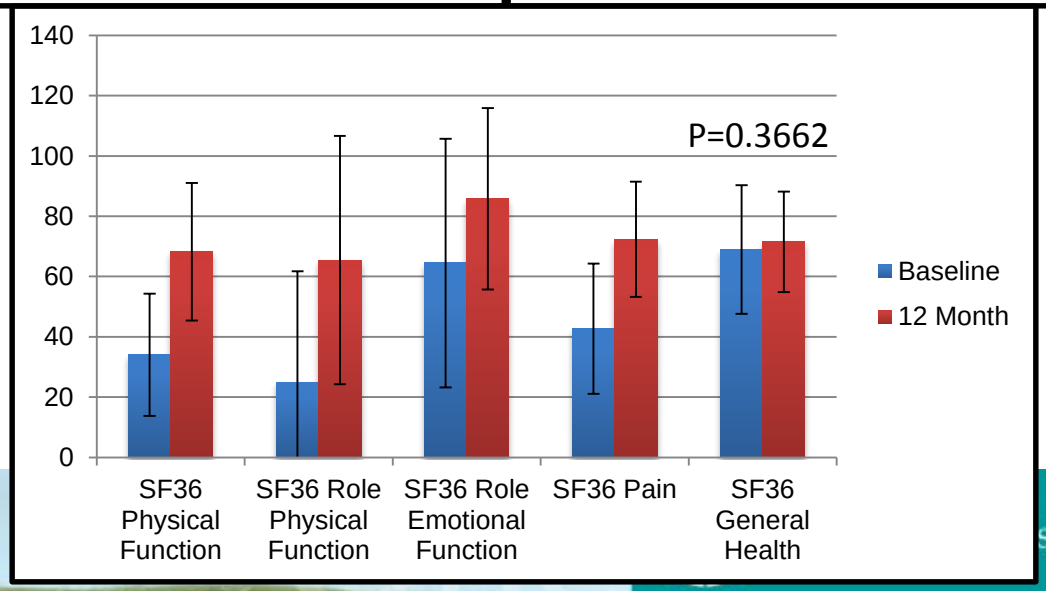

3
2.5
2
1.5
1
0.5
0
EQ5D Mobility
EQ5D Self Care
EQ5D Usual Activities
EQ5D Pain/Discomfort
EQ5D Anxiety/Depression


140
120
100
80
60
40
20
0
P=0.059
SF36 Physical Function
SF36 Role Physical Function
SF36 Role Emotional Function
SF36 Pain
SF36 General Health
Series1
12 Month

# PKA


50
45
40
35
30
25
20
15
10
5
0
OKS
WOMAC Pain
WOMAC Stiffness
Womac Physical Function


3
2.5
2
1.5
1
0.5
0
P=0.1191
EQ5D Mobility
EQ5D Self Care
EQ5D Usual Activities
EQ5D Pain/Discomfort
EQ5D Anxiety/Depression


140
120
100
80
60
40
20
0
P=0.3662
SF36 Physical Function
SF36 Role Physical Function
SF36 Role Emotional Function
SF36 Pain
SF36 General Health
Baseline
12 Month

# Comparison of TKA and PKA scores

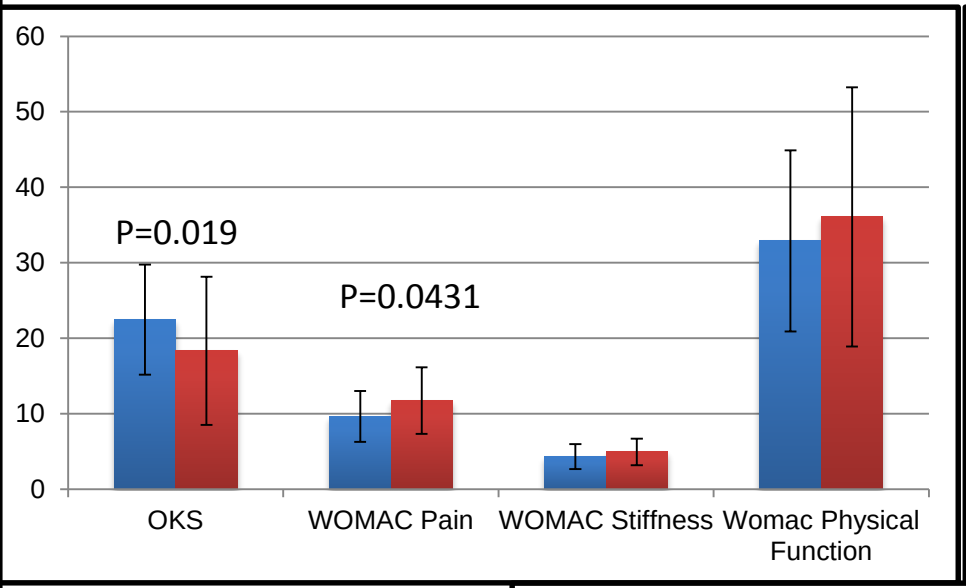
| | Difference (12month - Baseline) | | |
|---|---|---|---|
| | TKA : mean(SD) | PKA : mean(SD) | pvalue |
| OKS TOTAL | 20.56(8.00) | 18.25(8.55) | 0.1065‡ |
| WOMAC Pain | -8.14(3.91) | -6.69(3.85) | 0.010 |
| WOMAC Stiffness | -3.07(1.84) | -2.44(2.11) | 0.053 |
| WOMAC Physical Function | -24.53(12.37) | -21.1(14.16) | 0.078 |
| SF36 Physical functioning | 34.91(26.38) | 34.14(24.48) | 0.549 |
| SF36 Role functioning/physical | 42.92(51.36) | 40.46(47.45) | 0.655 |
| SF36 Role functioning/emotional | 26.67(52.2) | 21.31(43.05) | 0.677 |
| SF36 Pain | 32.11(23.04) | 29.67(26.01) | 0.450 |
| SF36 General health | 4.3(18.7) | 2.58(17.48) | 0.584 |
| EQ5D - Mobility | -0.64(0.48) | -0.63(0.52) | 0.960 |
| EQ5D - Self_Care | -0.11(0.36) | -0.11(0.48) | 0.746 |
| EQ5D - Usual Activities | -0.68(0.52) | -0.76(0.56) | 0.372 |
| EQ5D - Pain/Discomfort | -0.88(0.69) | -0.77(0.62) | 0.323 |
| EQ5D - Anxiety/Depression | -0.21(0.58) | -0.15(0.4) | 0.469 |

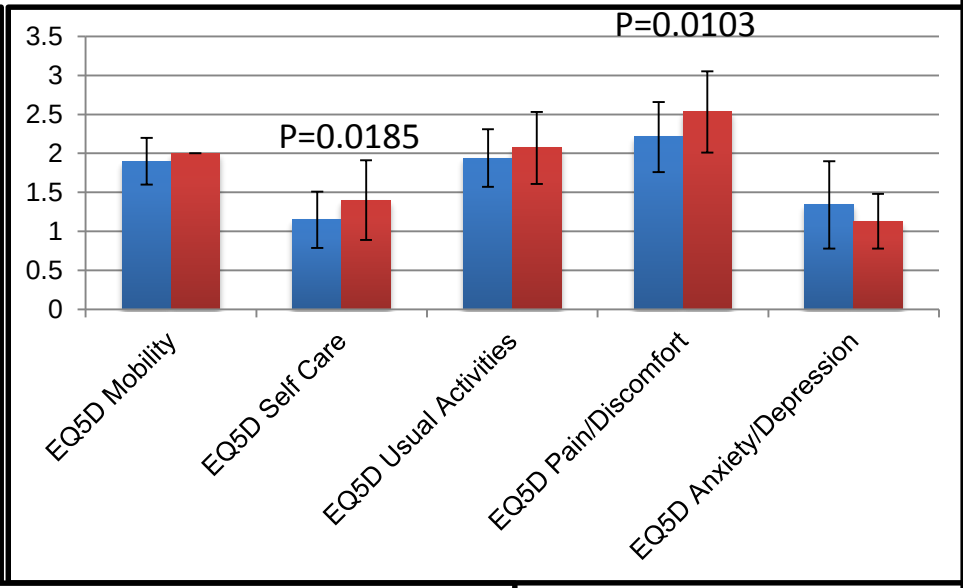
Minimal Clinically Important difference: 9-12 per Ehrich etl al (13) and 15per Escobar et al (14)

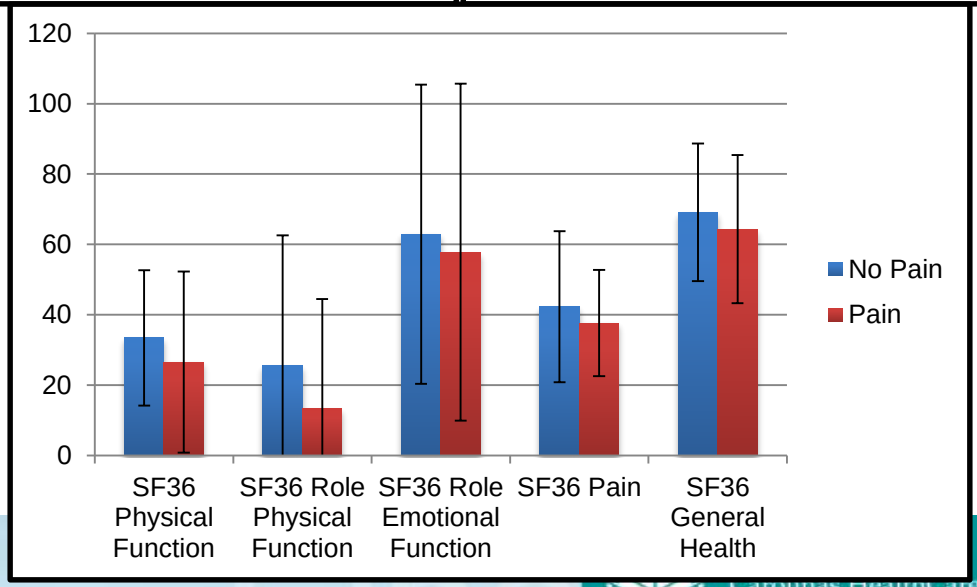
# Patient Factors

- Total Patients: 142
- Chronic Pain (15) vs No Pain (127)
  - Narcotic Medications
- Psychiatric History (5) vs No Psychiatric History (137)
  - Anxiety and Depression

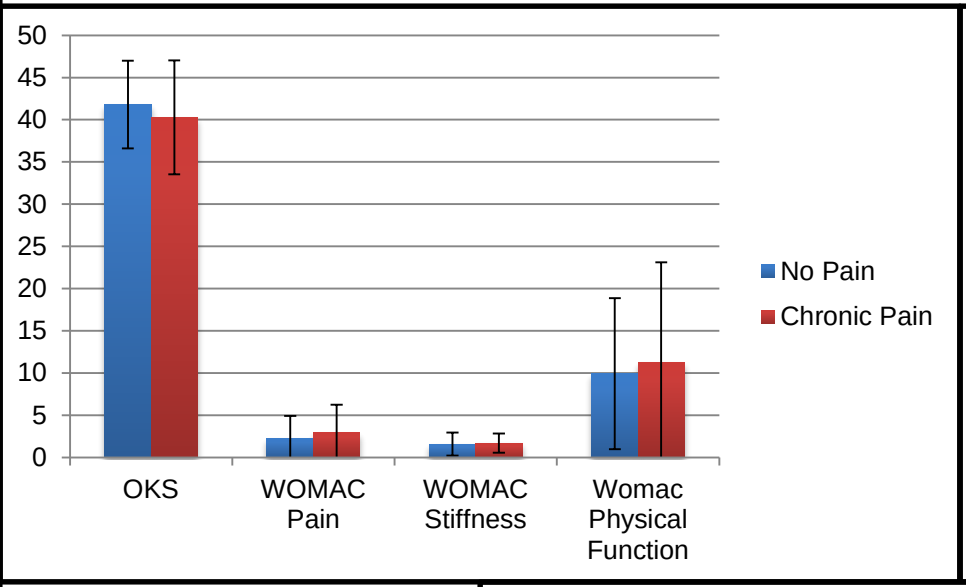
# Chronic Pain - Baseline

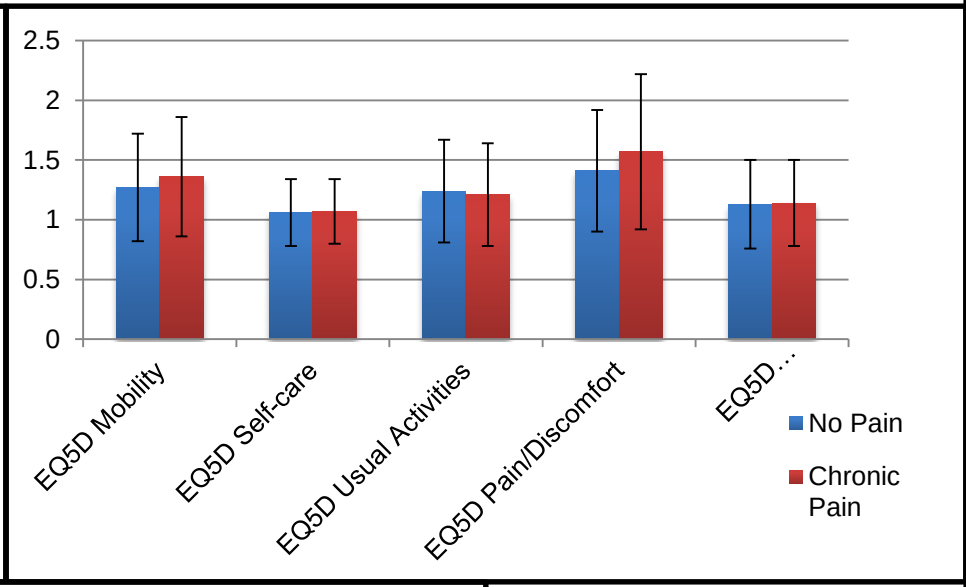


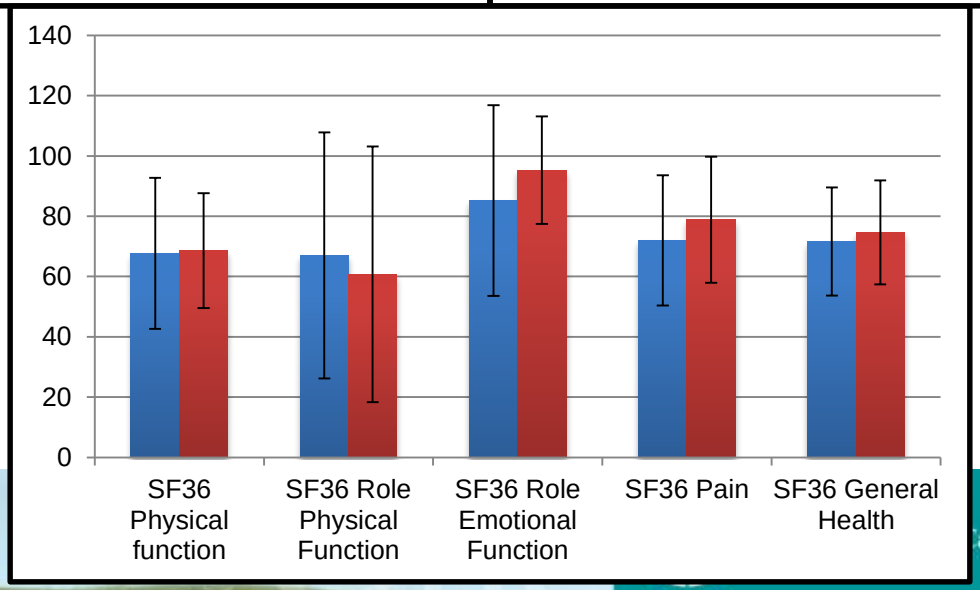



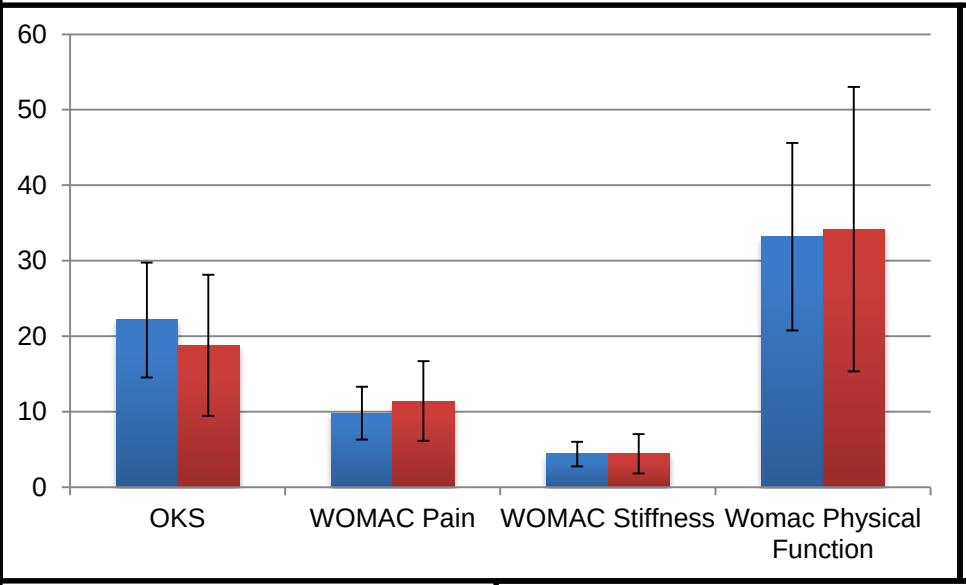
# Chronic Pain – 12 Months

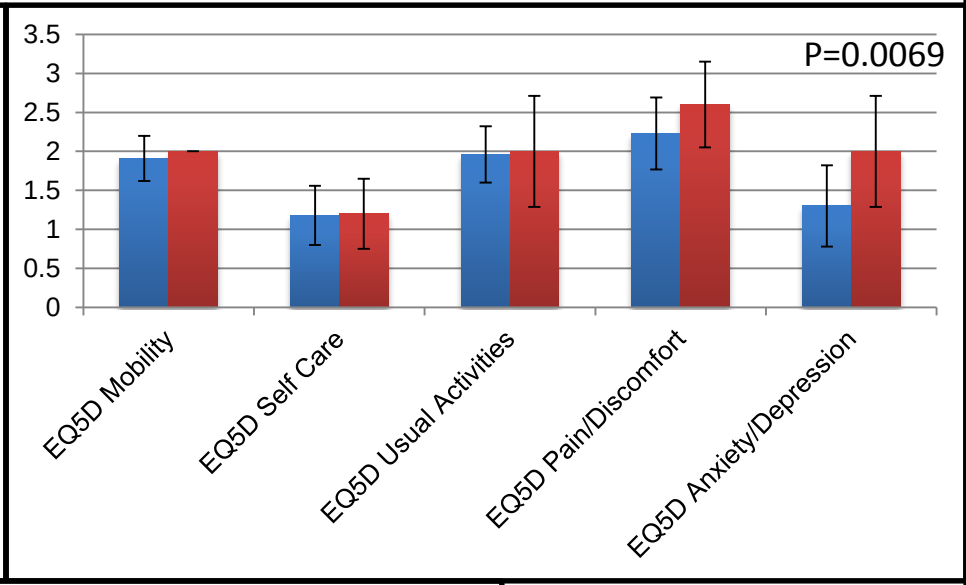


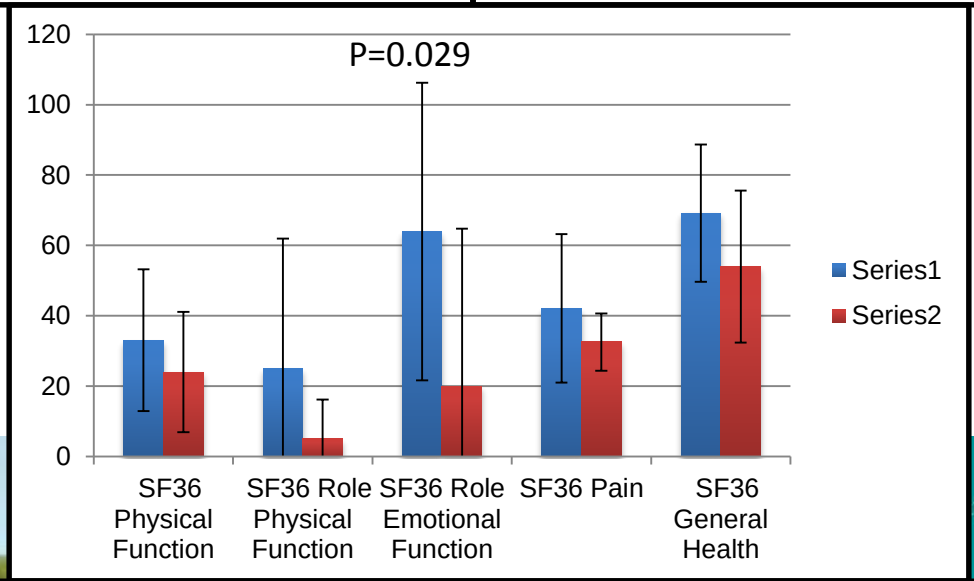



# Psych - Baseline



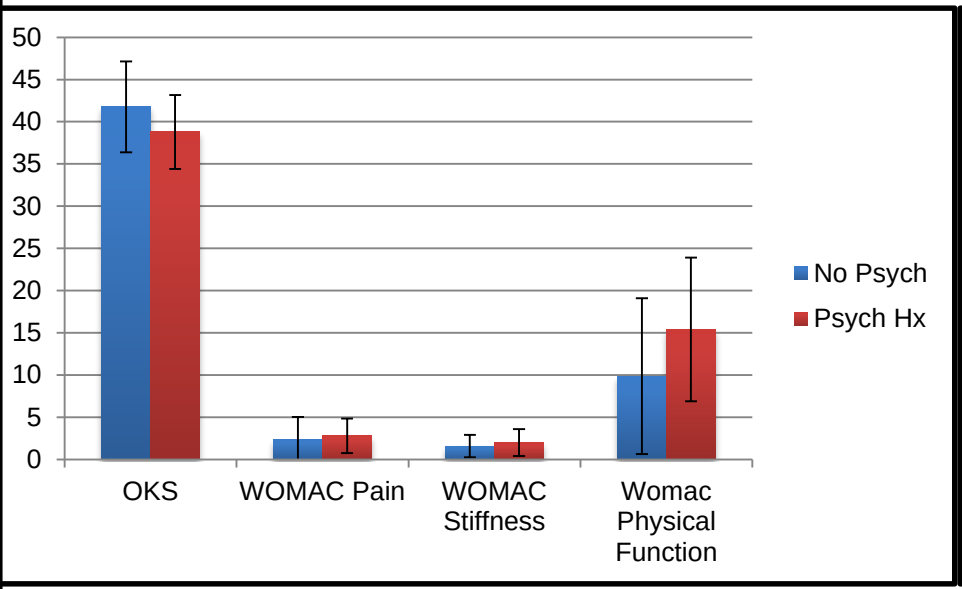



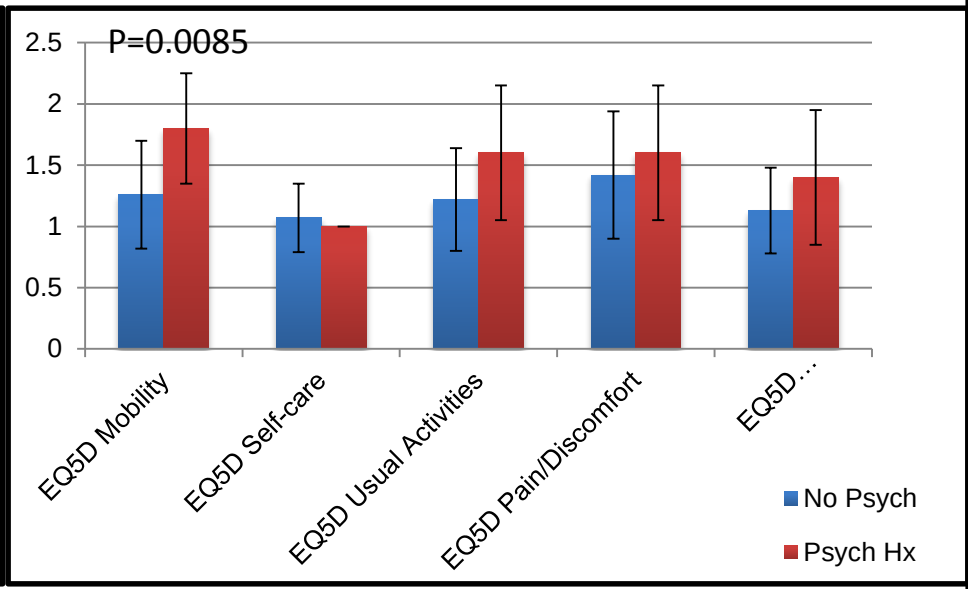



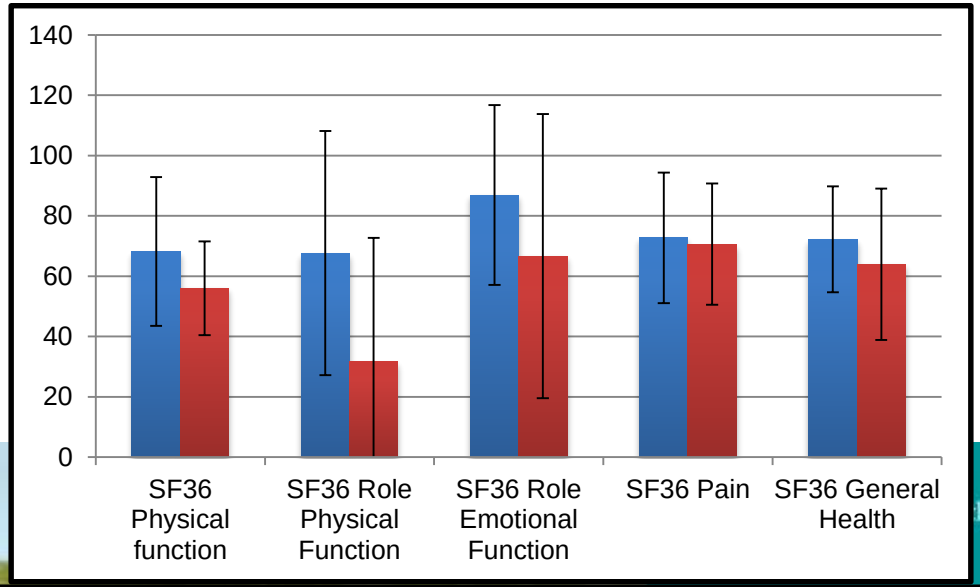



re System

# Psych – 12 Months






hCare System

# OKS breakdown

- Poor 0-26:  4 patients (2 TKA, 2 PKA)
  - TKA:  Post traumatic Arthritis with osteomyelitis
  - TKA:  Chronic Pain
  - PKA:  Chronic Back Pain
- Fair 27-33:  4 patients
  - PKA:  Chronic Pain
  - TKA:  Chronic Pain

# Complications

- 1 Re-hospitalization for postoperative anemia:
  - Admitted 6 days Post op.  79yo f with hx of Hemolytic anemia secondary to cold agglutinins. Hgb 7.4.  Symptomatic with mobilization
- 1 MUA of TKA within 90 days
  - TKA on 5/25/2011 and MUA on 7/13/2011:  Pt had <90 flexion at 6 weeks post op
- 1 NSTEMI 2 Months Post op (TKA)
- 1 PE (TKA) – IVC filter

# Limitations

- Lack of PKA revisions in our data set
  - Strict indications
- May benefit from more patients

# Conclusion

- All Pts Improved from Baseline as expected
  - When correct indications are used
- TKA Patients had significantly better improvement in WOMAC Pain score to PKA but not clinically different
- Pts with Chronic Pain start with significantly lower OKS, EQ5D Pain, and SF36 Pain.
  - Improve but not same level as Patients without Chronic Pain
- Pts with Psych History have significantly lower baseline EQ5D Anxiety/Depression and SF36 Emotional Role function scores
  - Improve but not to same level as Patients without Psychiatric Hx
- Patients with lower OKS may be multifactorial. Revision Surgery may not be beneficial if implant is stable on Exam and radiographically

# Special Thanks

- Dr. Mauerhan
- Rachel Seymour, PhD
- Nigel Rozario
- Ada Mayfield

# References


1. Eriksen J, Christensen J, Solgaard S, Schroder H. The cementless AGC 2000 knee prosthesis: 20-year results in a consecutive series Acta Orthop Belg. 2009. 75(2):225-33
2. Buechel FF, SR., Buechel FF, Jr., Pappas MJ, Dalessio J. Twenty-year evaluation of the New Jersey LCS Rotating Platform Knee Replacement. J Knee Surg. 2002. 15(2):84-9
3. Ritter, MA. The anatomical graduated component total knee replacement: A long-term evaluation with 20-year survival analysis. JBJS Br. 2009. 91(6):745-749
4. Price AJ, Svard U. A Second Decade lifetable Survival Analysis of the Oxford Unicompartmental Knee Arthroplsty Clin Orthop Relat Res. 2010. Aug
5. Price AJ, Waite JC, Svard U. Long term clinical results of the medial Oxford Unicompartmental knee arthroplasty. Clin Orthop Relate Res. 2005. 435:171-80
6. Ackroyd CE, Whitehouse SL, Newman JH, Joslin CC. Acomparative study of the medial St Georg sled and kineamtic total knee arthroplasties. Ten year survivorship. JBJS Br. 2002. 84(5):667-72
7. Price AJ, Dodd CA, Svard UG, Murrary DW. Oxford medial unicompartmental knee arthroplasty in patients younger and older than 60 years of age. JBJS Br. 2005. 87(11):1488-92
8. Tabor OB, Jr., Tabor OB. Unicompartmental arthroplasty: a long-term follow-up study. J Arthroplasty. 1998. 13(4):373-9
9. Baker PN, van der Meulen JH, Lewsey, J, Gregg PJ. The role of pain and function in determining patient satisfaction after total knee replacement. Data from the National Joint Registry for England and Wales. JBJS Br. 2007. 89(7):893-900

# References


10. Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? CORR. 2010. 468(1):57-63.
11. Edwards RR, Haythornthwaite, JA, Smith MT, Klick B, Katz JN. Catastrohizing and depressive symptoms as prospective predictors of outcomes following total knee replacement. Pain Res Manag. 2009. 14(4)307-11
12. Goodfellow JW, O'Connor JJ, Murray DW. A critique of revision rate as an outcome measure: RE-INTERPRETATION OF KNEE JOINT REGISTRY DATA. JBJS Br. 2010. 92(12):1628-31.
13. Ehrich EW, Davies GM, Watson DJ, Bolognese JA, Seidenberg BC, Bellamy N. Minimal perceptible clinical improvement with the Western Ontario and McMaster University index questionaire and global assessments in the patients with osteoarthritis. J Rheumatol. 2000. 27(11):2635-41.
14. Escobar A, Quintana JM, Bilbao A, Arostegui I, Lafuente I, Vidaurreta I. Responsiveness and clinically important differences for the WOMAC and SF-36 after total knee replacement. Osteoarthritis and Cartilage. 2007. 15(3):273-280.

# • DOES AN ENHANCED RECOVERY PATHWAY DECREASE LENGTH OF STAY AFTER TOTAL KNEE ARTHROPLASTY?


- Mitchell R. Klement, M.D.; Brian T. Nickel, M.D.; W. Michael Bullock, M.D., PhD.; Alexander J. Lampley, M.D.; Thorsten M. Seyler, M.D., PhD.; Samuel S. Wellman, M.D., Michael P. Bolognesi, M.D., Stuart M.B, CH.B.



North Carolina Orthopedic Association

October 11, 2015

Kiawah Island, SC

# Background

- Total knee arthroplasty (TKA), one of the larger, and more painful orthopedic procedures, has doubled in the United States over the last decade and, with an aging population, the incidence is only expected to increase.

- In addition, growing health care financial burden places emphasis on institutions to provide high quality, cost effective care in an efficient manner for this large patient population.

- Many multimodal pain regimens have been described in attempts to reduce length of stay (LOS) but the ideal regimen is yet to be determined.

# Methods

- From January 1, 2013 to October 1, 2014 three perioperative pathways have been used to address surgical pain at our institution after TKA including
  - femoral nerve catheter plus patient controlled analgesia (PCA, Group1),
  - Exparel® plus single shot femoral nerve block plus an oral analgesic protocol (Group 2),
  - adductor canal catheter and posterior capsule single shot block plus an oral analgesic protocol (Group 3).

- Little modification has occurred in respect to surgical technique, implant choice, or post-operative physiotherapy. The primary outcome measure was length of stay and secondary outcome was patient satisfaction.

# Results

- Overall, there were 134 patients in Group 1, 270 patients in Group 2, and 123 patients in Group 3.

- Patients in Group 3 who received adductor canal catheters have a lower LOS (2.29 days) and higher HCAHPS pain scores (79.8%).

# Conclusions

- Based of the results in this study, the use of an adductor canal catheter and posterior capsule single shot block plus a multimodal oral analgesic protocol resulted in a lower length of stay and improved pain management scores at a large tertiary academic center.

# THANK YOU

Wake Forest® School of Medicine

# Patient Factors and Cost Associated with 90-day Readmission Following THA

**Johannes F. Plate, MD, PhD[1]; Matthew L. Brown, MD[1]; Andrew D. Wohler, BS[1]; Thorsten M. Seyler, MD, PhD[1,2]; Jason E. Lang, MD[1]**

[1]Wake Forest School of Medicine, Winston-Salem, NC
[2]Duke University, Durham, NC

# Financial Disclosure

No conflict of interest to report.

# Introduction

- Projected 174% growth in total hip arthroplasty (THA) in the next 15 years Kurt et al. *JBJS Am* 2007; Bashinskaya et al. *ISRN Orthop* 2012
  - 570,000 THA annually in 2030
- Increased emphasis on cost control from Centers of Medicare/Medicaid (CMS) Bozic et al. *CORR* 2014
  - Value based payments
    - ➢Episode of care and bundled payments
      - Potential for cost savings
      - Improved continuum of care
      - Improved collaboration among care team

# Bundled payments


- Reimbursement for episode of care
  - No fee-for-service
  - Includes all services provided
- Financial incentives
  - ➢Coordinated, reliable, quality care

➢Financial risks Cutler *N Engl J Med* 2012

- Readmission costs
  - Increase with severity of illness(SOI) Kirdly et al. *J Arthroplasty* 2014

# Adjusted reimbursement models

- Diagnostic related group-severity of illness (DRG-SOI)
  Mechanic *N Engl J Med* 2012
  - Patient primary diagnosis and co-morbidities
  - 1-4 minor to extreme SOI
- Higher SOI
  - Readmission rates up to 26% Kirdly et al. *J Arthroplasty* 2014
  - Increased readmission cost
    - Higher financial burden for complex patients

➢Limited data on actual reimbursement for readmissions and revisions

# Purpose

- Identify specific areas of care for cost savings during unplanned readmissions

# Hypothesis

- Increased readmission costs with higher SOI
- Increased actual reimbursement with higher SOI

# Materials and Methods

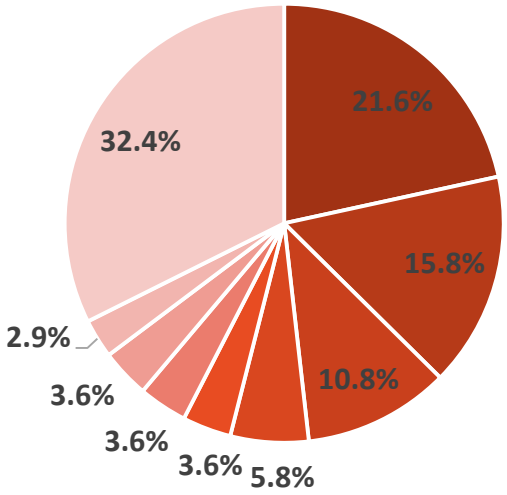
- Retrospective review of all primary total hip arthroplasties (THA) 2005 – 2012
  - Identify patients with 90-day readmission
- Patient demographics
  - DRG-SOI, co-morbidities
- Hospital billing system query
  - Emergency department
  - Evaluations and consults
  - General hospital costs
  - Imaging and diagnostic studies
  - Laboratory studies
  - Medications and transfusions
  - Operating room costs
- ANOVA, t-test with alpha 0.05

# Results

- 1781 primary THA in 7-year period
  - ➢139 readmissions (8.93%) in 90 days after surgery

| Table 1. Patient Demographics | |
|---|---|
| **Gender N(%)** | |
| **Male** | 49 (41) |
| **Female** | 71 (59) |
| **Mean Age (SD), years** | 62.6 (15.4) |
| **Age Group N(%), years** | |
| **<60** | 51 (43) |
| **>60-70** | 28 (23) |
| **>70-80** | 21 (17) |
| **>80** | 20 (16) |
| **Mean BMI (SD), kg/m$^2$** | 29.54 (7.30) |

# Causes for readmission




- Hip Infection, 21.6%
- Dislocation, 15.8%
- Wound Complication, 10.8%
- Hardware Failure, 5.8%
- DVT, 3.6%
- Chest Pain, 3.6%
- Pneumonia, 3.6%
- Periprosthetic fracture, 2.9%
- Other, 32.4%

| Other (32.4%): | | | |
|---|---|---|---|
| **Hip pain** | 2.2% | Confusion | 0.7% |
| **Pulmonary Embolism** | 2.2% | Diarrhea | 0.7% |
| **Nausea/Vomiting** | 2.2% | Fall (associated hemothorax) | 0.7% |
| **Urinary tract infection** | 2.2% | Groin Pain | 0.7% |
| **Clostridium difficile colitis** | 1.4% | Heart Failure | 0.7% |
| **Hemorrhagic shock** | 1.4% | Jaundice | 0.7% |
| **Pyelonephritis** | 1.4% | Kidney stone | 0.7% |
| **Fall (associated fracture)** | 1.4% | Knee Infection | 0.7% |
| **Abdominal Pain** | 0.7% | Optic Neuritis | 0.7% |
| **Acute Cholecystitis** | 0.7% | Pericardial Effusion | 0.7% |
| **Acute Ischemia of RLE** | 0.7% | Rectal Bleeding | 0.7% |
| **Acute Renal Failure** | 0.7% | Sepsis | 0.7% |
| **Anemia** | 0.7% | Septic Thrombophlebitis | 0.7% |
| **AV Block** | 0.7% | Sudden loss of vision | 0.7% |
| **Bacterial Peritonitis** | 0.7% | Syncope | 0.7% |
| **Carotid Stenosis** | 0.7% | Urinary Retention | 0.7% |
| **Complicated Migraine** | 0.7% | | |

# Results

- Total hospital costs $2,083,113
  - 62% surgical reasons $1,539,482
  - 38% medical reasons $580,062.
    - Surgical reasons mean cost $17,105
    - Medical reasons mean cost $11,095
    - p=0.002
    - Current fee-for-service reimbursement
    - Mean net loss for hospital
      - $1,321 for medical readmissions
      - $2,932 for surgical readmissions

# Costs and Reimbursement

| Readmission Reason | Total Cost | Reimbursement | OR costs | Imaging, diagnostic studies | Evaluations | Labs | Meds, transfusions | General hospital costs | Emergency department |
|---|---|---|---|---|---|---|---|---|---|
| Hip Infection | $22,394 | $16,746 | $8,333 | $1,331 | $600 | $1,760 | $2,345 | $7,906 | $500 |
| Dislocation | $15,014 | $13,135 | $6,602 | $620 | $452 | $551 | $957 | $5,679 | $659 |
| Wound Complication | $9,741 | $9,893 | $3,493 | $434 | $348 | $748 | $1,135 | $4,274 | $276 |
| Hardware Failure | $23,177 | $19,326 | $14,102 | $593 | $512 | $973 | $1,423 | $5,500 | $602 |
| Chest Pain | $11,792 | $11,427 | $781 | $3,264 | $84 | $614 | $979 | $5,491 | $612 |
| Pneumonia | $18,636 | $15,658 | $2,001 | $1,472 | $342 | $1,964 | $3,085 | $9,705 | $779 |
| DVT | $14,309 | $10,789 | $61 | $1,902 | $295 | $1,465 | $2,024 | $8,173 | $484 |
| Periprosthetic fracture | $22,490 | $25,236 | $13,870 | $595 | $689 | $453 | $1,234 | $5,650 | $0 |
| Pulmonary Embolism | $11,353 | $12,305 | $56 | $1,075 | $248 | $630 | $1,545 | $7,521 | $665 |

- Significant difference in average hospital costs (p=0.012)

# Costs by DRG-SOI

| DRG-SOI | Grand Total | Emergency department | Evaluations | General hospital costs | Labs | Meds, transfusions | OR costs | Imaging, diagnostic studies |
|---|---|---|---|---|---|---|---|---|
| 1 | $7,600 | $691 | $376 | $3,245 | $366 | $711 | $3,349 | $536 |
| 2 | $12,442 | $534 | $378 | $4,233 | $750 | $1,108 | $6,261 | $911 |
| 3 | $20,462 | $512 | $546 | $8,468 | $1,448 | $2,184 | $6,637 | $1,421 |
| 4 | $21,933 | $484 | $685 | $8,416 | $2,623 | $1,945 | $6,660 | $2,237 |

- Significant correlation between increasing SOI and hospital costs ($p<0.05$)

# Route of Admission

| Route | Grand Total | Emergency department | Evaluations | General hospital costs | Labs | Meds, transfusions | OR costs | Imaging, diagnostic studies |
|---|---|---|---|---|---|---|---|---|
| Emergency department | $13,697 | $560 | $397 | $6,232 | $1,024 | $1,416 | $4,002 | $1,139 |
| Clinic | $18,271 | $480 | $535 | $6,364 | $1,190 | $1,907 | $8,192 | $995 |
| Outside hospital or rehabilitation | $25,275 | $0 | $510 | $7,051 | $1,135 | $1,389 | $15,259 | $1,610 |
| p-value | 0.006 | 0.513 | 0.096 | 0.990 | 0.690 | 0.178 | >0.001 | 0.478 |

- 3 routes of admission
  - Emergency department (N=100)
  - Clinic (n=49)
  - Transfers from outside hospitals or inpatient units (n=10)
- Transfer from outside hospitals or inpatient rehabilitation units significantly higher overall hospital costs (p=0.006) OR costs (p=0.001)
- Median SOI for patients transferred from outside hospital or inpatient rehabilitation was 3 compared to a median SOI of 2 for patients that were admitted from the ED or clinic (p=0.193).

# Insurance

- 98 readmissions Medicare/Medicaid
- 41 readmissions private payers

- Readmission costs
  - Medicare/Medicaid $14,967
  - Private payers $15,032, p=0.975
- Fee-for-service reimbursement
  - Mean net loss $2,643 Medicare/Medicaid
  - Mean net gain $76.28 private payers

# Discussion

- Most readmissions for surgical reasons
  - Higher cost compared to medical reasons
- Highest mean readmission costs
  - Hardware failure
  - Infection
  - Pneumonia.
- Significant correlation between increasing SOI and increasing costs for physician evaluation, imaging, laboratory workup, medication and transfusions, and overall hospital cost.
- Direct transfers from outside hospitals or inpatient rehabilitation significantly higher overall hospital costs and OR costs
  - Higher SOI

# Discussion

- Overall reimbursement 83%
  - Medical reasons 87%
  - Surgical reasons 82%
- Lower reimbursement for Medicare/Medicaid
  - Expected bundled payments for private insurance
  - Importance of payer-mix in the future

# Discussion

- Post-acute care setting
  - Inpatient rehabilitation, skilled nursing facility, home health
  - Higher readmission costs for patient transfers from inpatient rehab

➢Incentives for discharge home

# Acknowledgments

Wake Forest® School of Medicine


**Orthopaedic Surgery**
Jason E. Lang, MD
John S. Shields, MD
Max K. Langfitt, MD
Gary G. Poehling, MD
Beth P. Smith, PhD

**Orthopaedic Residents**
Thorsten M. Seyler, MD PhD
Matthew L. Brown, MD
Sandeep Mannava, MD PhD
Daniel N. Bracey, MD




**Medical Students**
Andrew Wohler, BS
Aneitra Hoggard, MD
Marco Augart, MD
Dan Sun, MD
Sarah Von Thaer, MD
John Allen, MD

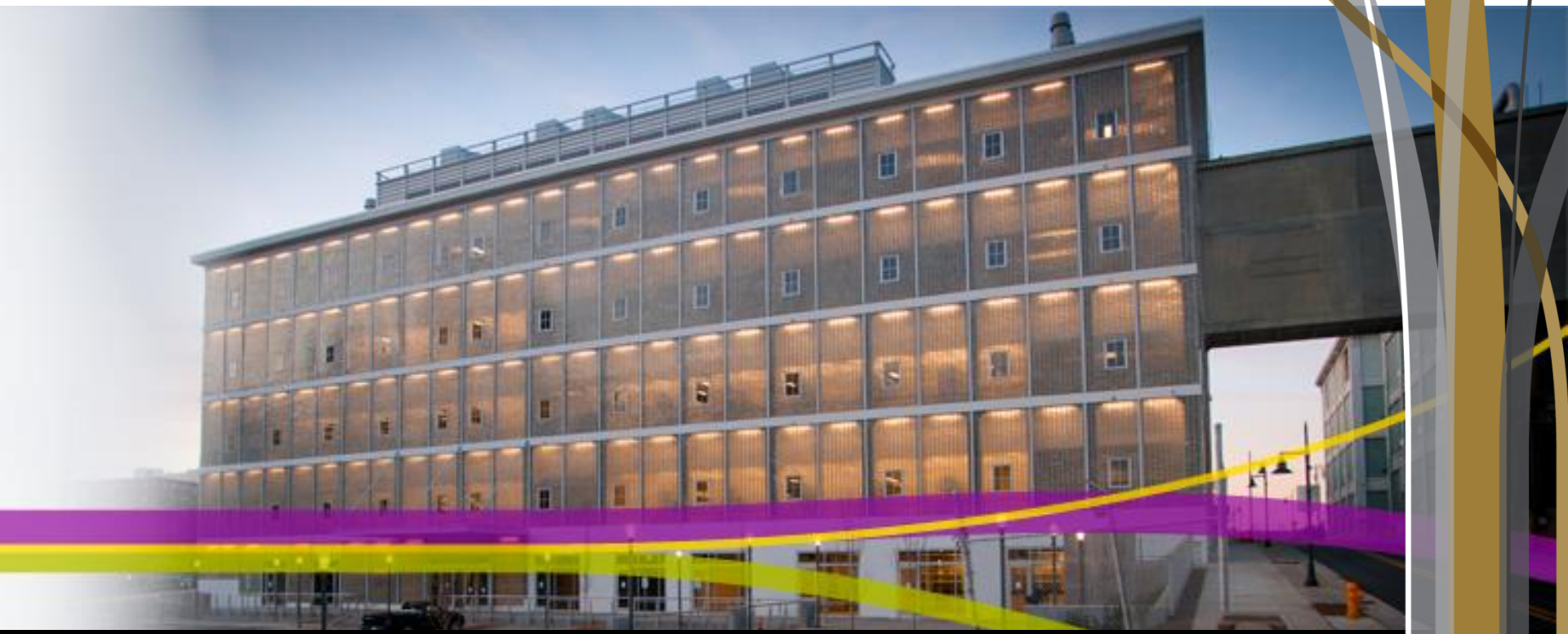
**Research Staff**
Deanna Sizemore
Martha Holden
Jan Kelly
Eileen Martin


## Department of Orthopaedic Surgery

Wake Forest®
School of Medicine

# Thank you

Johannes F. Plate, MD, PhD
jplate@wakehealth.edu



# Vancomycin Administration in Penicillin Allergic Patients Undergoing Total Joint Arthroplasty

John Ruder MD,
Tim Tan MD,
Michael Ruffalo MD,
Javad Parvizi MD, FRCS,
Antonia F. Chen MD, MBA,
Bryan D. Springer MD

North Carolina Orthopaedic Association
October 11th, 2015

Carolinas Medical Center
Carolinas HealthCare System

OCRI
ORTHOCAROLINA
RESEARCH INSTITUTE

OrthoCarolina
HIP & KNEE CENTER

ROTHMAN
INSTITUTE

# Disclosures

- We have nothing to declare for this study

HIP & KNEE CENTER

# Background

- Perioperative antibiotic prophylaxis important for prevention of PJI
- PCN allergy is often reported by patients
- Alternative antibiotics are frequently given instead of a cephalosporin
  - Protocols vary by institution
- Literature regarding efficacy of alternative abx are variable

HIP & KNEE CENTER

# Background

## Surgical Site Infection After Arthroplasty: Comparative Effectiveness of Prophylactic Antibiotics

### Do Surgical Care Improvement Project Guidelines Need to Be Updated?

Brent Ponce, MD, Benjamin Todd Raines, MA, ATC, Rhiannon D. Reed, MPH, Catherine Vick, MS, Joshua Richman, MD, PhD, and Mary Hawn, MD, MPH

## Antibiotic Prophylaxis in Primary Hip and Knee Arthroplasty

### Comparison Between Cefuroxime and Two Specific Antistaphylococcal Agents

Minos E. Tyllianakis, MD,* Athanasios Ch. Karageorgos, MD,† Markos N. Marangos, MD,‡ Alkis G. Saridis, MD,* and Elias E. Lambiris, MD*

## Is it Time to Include Vancomycin for Routine Perioperative Antibiotic Prophylaxis in Total Joint Arthroplasty Patients?

Eric B. Smith, MD, Rachael Wynne, RN, Ashish Joshi, MD, MPH, Hans Liu, MD, and Robert P. Good, MD

HIP & KNEE CENTER

# Purpose

To determine if PCN or cephalosporin allergic patients who received vancomycin monotherapy are at an increased risk of developing PJI compared to non-PCN allergic patients receiving cefazolin.

HIP & KNEE CENTER

# Methods

- Multi-institutional retrospective review (n=11523)
- PCN allergic receiving vancomycin vs. non-PCN allergic receiving cefazolin
- Exclusion criteria: multiple abx, unavailable abx info, or other abx
- PJI was identified using ICD9 codes and confirmed by manual review
- Multivariate analysis performed

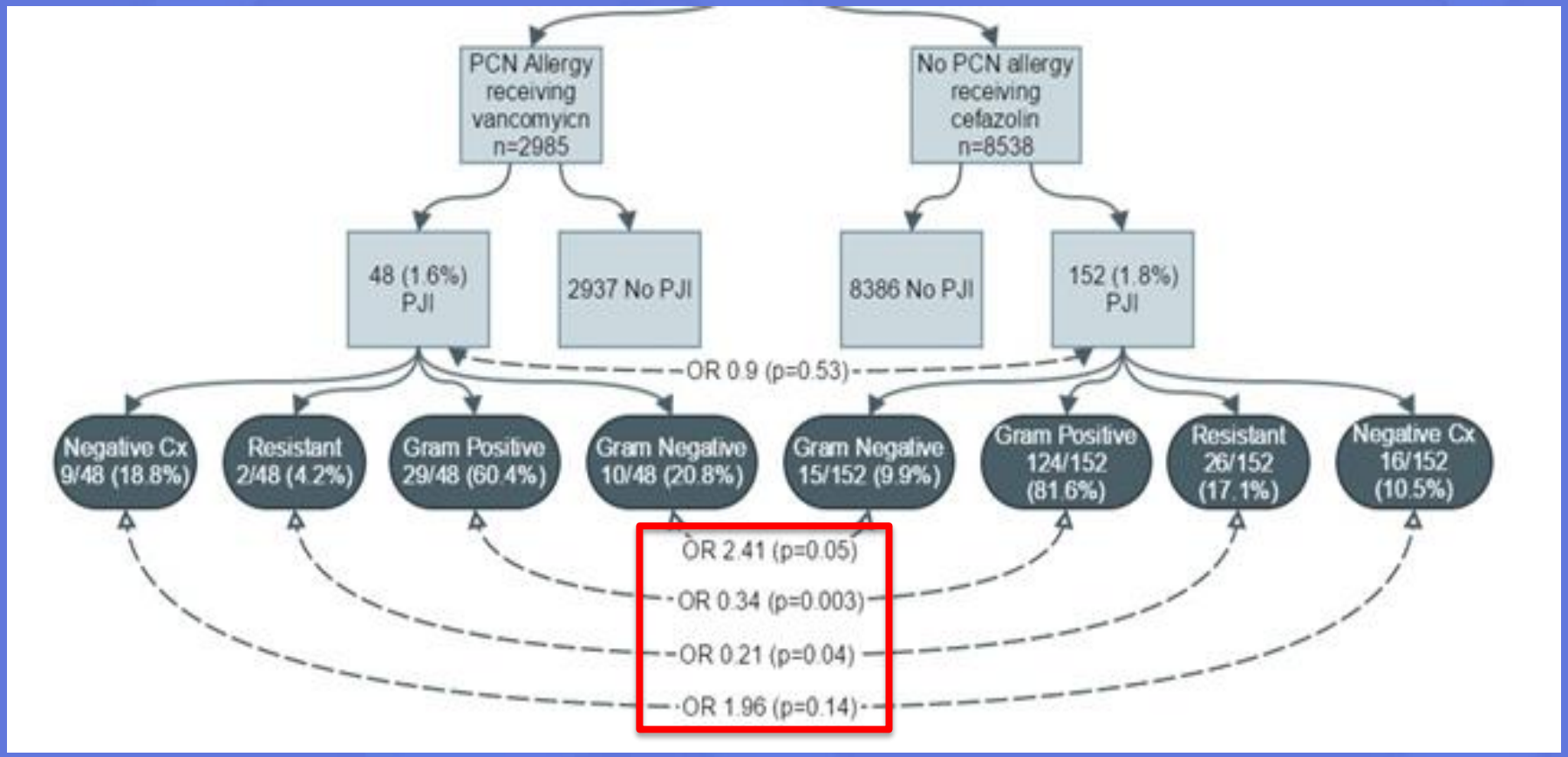
HIP & KNEE CENTER

# Results

- No difference in Overall PJI rate (OR 0.9; p=0.54)
  - PCN allergic: 1.6% (48/2937)
  - Non PCN allergic: 1.8% (152/8386)

– Organism profile varied
  - PCN allergy group had more gram negatives, but fewer antibiotic resistant PJIs and gram positives

HIP & KNEE CENTER


PCN Allergy receiving vancomyicn n=2985
No PCN allergy receiving cefazolin n=8538
48 (1.6%) PJI
2937 No PJI
8386 No PJI
152 (1.8%) PJI
OR 0.9 (p=0.53)
Negative Cx 9/48 (18.8%)
Resistant 2/48 (4.2%)
Gram Positive 29/48 (60.4%)
Gram Negative 10/48 (20.8%)
Gram Negative 15/152 (9.9%)
Gram Positive 124/152 (81.6%)
Resistant 26/152 (17.1%)
Negative Cx 16/152 (10.5%)
OR 2.41 (p=0.05)
OR 0.34 (p=0.003)
OR 0.21 (p=0.04)
OR 1.96 (p=0.14)

# Limitations

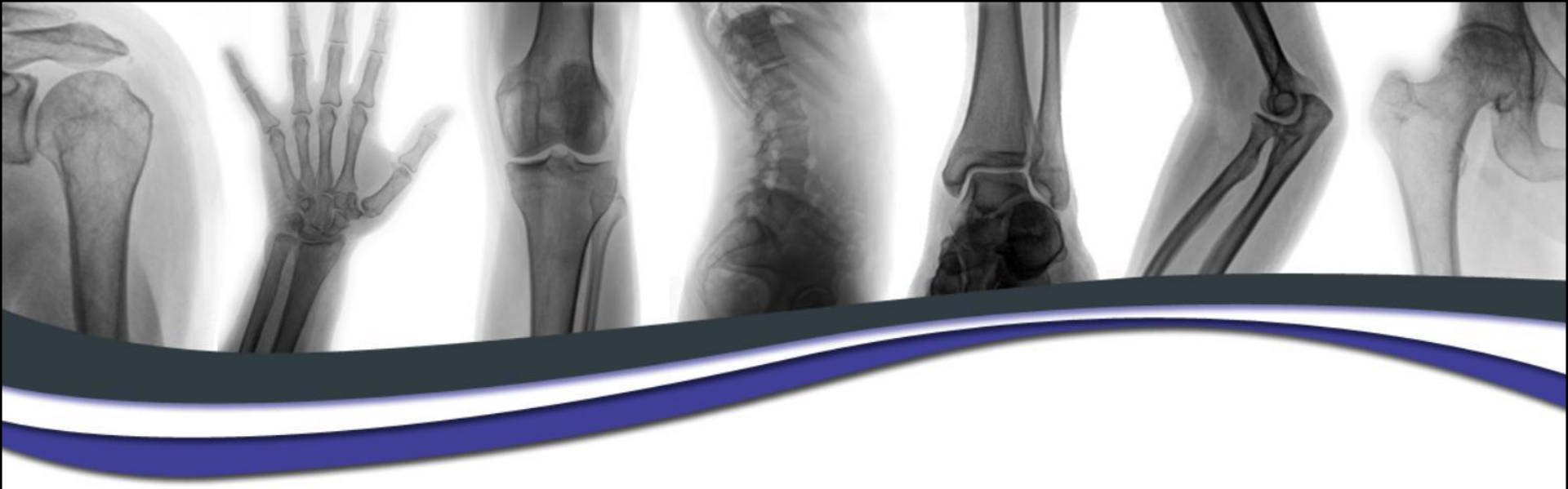
- Retrospective nature
- Additional abx in PCN allergic pts not evaluated
- Acute vs. chronic PJI not distinguished

HIP & KNEE CENTER

# Conclusions

- No difference in rate of PJI in both groups
- A higher rate of gram negatives PJI in Vancomycin group
  - decreased resistant organisms
- Future studies needed to determine optimal abx in PCN allergic patients

HIP & KNEE CENTER



# THANK YOU.

R Trust.
ROTHMAN
INSTITUTE

OrthoCarolina

# Alarming National Obesity Trends in Revision Total Knee Arthroplasty

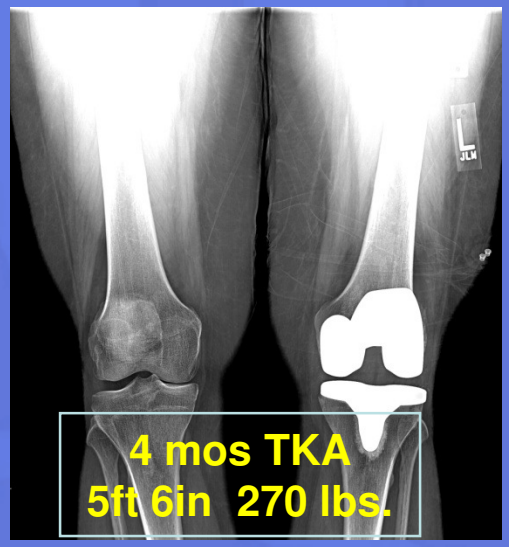
**Susan Odum, PhD**
Bryce Van Doren, MPA, MPH
Bryan Springer, MD

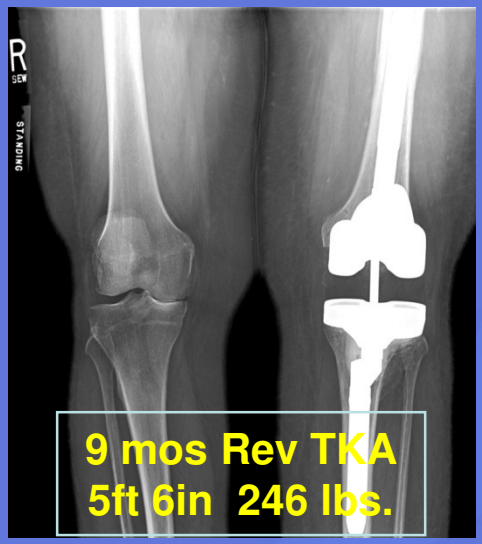
# Introduction

- Rate of total knee arthroplasty (TKA) procedures is increasing in parallel with population obesity rates
- As the average age of TKA patients decreases, the proportion of obese primary TKA patients increases.
- 69% of index TKA patients remain at the same preoperative weight thus obesity remains risk factor at revision

# Purpose

To determine the national trends of obesity rates among revision TKA patients in the U.S over the last decade.

# Methods

- Weighted data from 2002-2012 releases of the Nationwide Inpatient Samples were analyzed.
- Identified patients undergoing rTKA using ICD-9 procedure codes for unspecified component(s) (81.55), all components (00.80), tibial component (00.81), femoral component (00.82), patellar component (00.83), and liner exchanges (00.84).
- Patients classified as obese or non-obese using AHRQ obesity comorbidity indicator

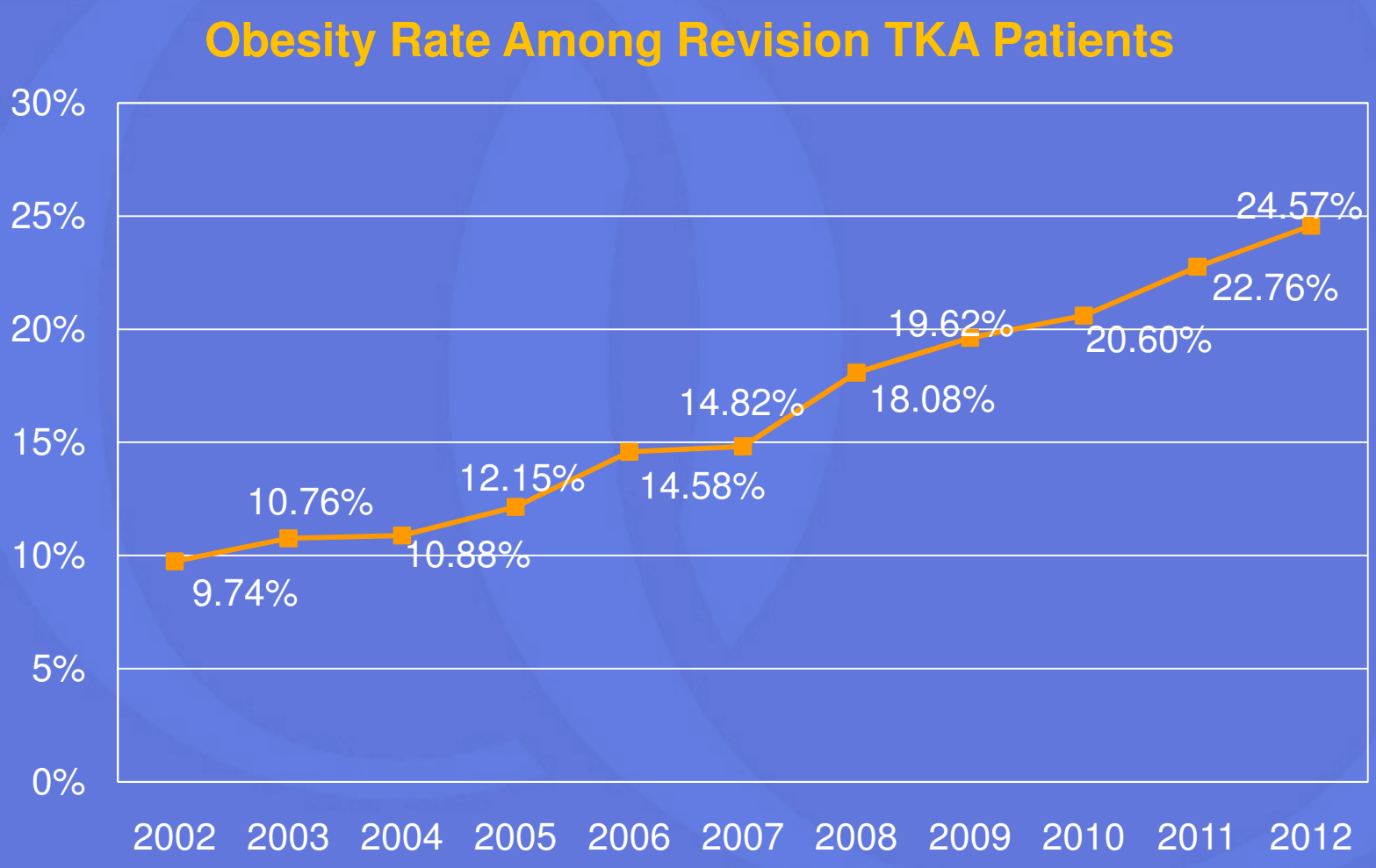
# Methods

- Unweighted Study Data included 83,093 rTKA patients
  - Weighted data represent 451,982 rTKA patients between 2003 and 2012
- Demographics
  - 59% female, 41% male
  - Average age: 65.6 years
  - Overall Obesity Rate: 17.4%

# Results

- The rate of obesity among revision TKA patients more than doubled between 2002 and 2012.
- Adjusting for patient demographics and facility characteristics, the odds of obesity in rTKA more than quadrupled during this time period.
- The multivariate analysis also shows a steady incline with the largest incremental increase occurring between 2007 and 2008.

# Results


Obesity Rate Among Revision TKA Patients
30%
25%
20%
15%
10%
5%
0%
9.74%
10.76%
10.88%
12.15%
14.58%
14.82%
18.08%
19.62%
20.60%
22.76%
24.57%
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

# Results

| Year | Adjusted Odds Ratio | 95% CI | p-value |
|---|---|---|---|
| 2002 | 1.00 | - | - |
| 2003 | 1.12 | 1.02-1.24 | <0.0001 |
| 2004 | 1.11 | 1.00-1.23 | <0.0001 |
| 2005 | 1.25 | 1.13-1.38 | <0.0001 |
| 2006 | 1.51 | 1.37-1.68 | <0.0001 |
| 2007 | 1.55 | 1.41-1.72 | <0.0001 |
| 2008 | 3.60 | 3.26-3.97 | <0.0001 |
| 2009 | 3.95 | 3.58-4.36 | <0.0001 |
| 2010 | 3.80 | 3.44-4.19 | <0.0001 |
| 2011 | 4.13 | 3.74-4.55 | <0.0001 |
| 2012 | 4.52 | 4.10-4.99 | <0.0001 |

# Conclusion

- Obesity rate among revision TKA patients is increasing at an alarming rate and outpaces that of index TKA patients
- Revision TKA is not considered elective
- The best opportunity for BMI reduction occurs prior to the index procedure.
- To give patients an advantage for a good outcome, surgeons need to optimize their patients prior to the index TKA.

# Thank you


OCRI
ORTHOCAROLINA
RESEARCH INSTITUTE
OrthoCarolina
HIP & KNEE CENTER

Wake Forest®
School of Medicine

# Incidence of heterotopic ossification in direct anterior vs. posterior approach to total hip arthroplasty: a retrospective radiographic review

Elizabeth A Newman, MD; David C Holst, MD; Daniel N Bracey, MD; Gregory B Russell, MS, Jason E Lang, MD

Department of Orthopaedic Surgery, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157

# Conflict of Interest

The authors have no relevant conflict of interest with regards to this study to declare

# Purpose

To investigate the incidence of heterotopic ossification (HO) following direct anterior approach total hip arthroplasty (DAA) compared to posterior approach, performed by a single surgeon at one institution

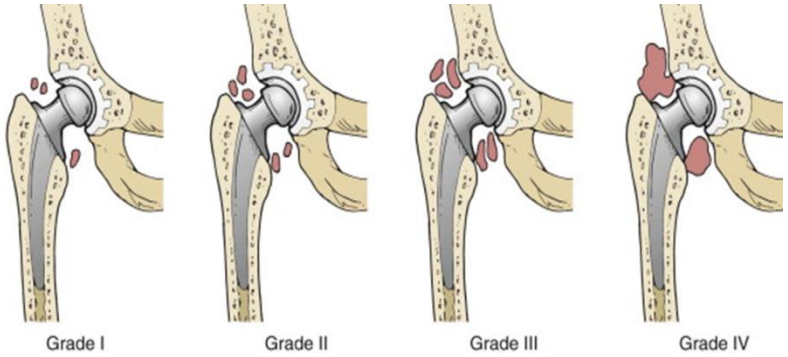
# Introduction

- HO - common complication following THA, leading to hip pain and decreased range of motion
- Pathogenesis of HO - not fully understood. It has been proposed that trauma to soft tissues is an inciting event
- A potential advantage of the DAA is that it permits less soft tissue trauma during surgery compared to the posterior approach

Direct Anterior Approach

# Methods

- Primary THAs performed by the senior author (JEL) over a 70-month period were reviewed
- 235 DAA THAs and 120 posterior THAs
- The following data was collected: surgical approach, gender, age at time of operation, race, BMI, comorbidities, pre-operative diagnosis, type of osteoarthritis (atrophic vs. normotrophic vs. hypertrophic), ASA classification, blood loss, operative time, number of blood transfusions required, length of hospital stay, and DVT prophylaxis received
- Mean time of follow up - 2.04 years (range 0.5-11.6 years)
- HO graded based on the standard Brooker classification system
- To assess differences in observed rates of HO and clinically significant HO, independent study measures were analyzed using using logistic regression. Estimates for odds ratios and corresponding 95% confidence intervals were generated.



Brooker Classification


Brooker Grade 3

Brooker Grade 4

# Cohort operative parameters/demographics comparison

| | Anterior Approach (n=235) | Posterior Approach (n=120) | Statistical Significance |
|---|---|---|---|
| **Mean Age (SD)** | 62.8 ±12.3 years | 58.5 ±11.9 years | p = 0.002 |
| **Female** | 54.0% | 57.1% | ns |
| **Body Mass Index (BMI)** | 28.6 ±5.1 kg/m$^2$ | 34.2 ±9.2 kg/m$^2$ | p < 0.0001 |
| **Comorbidities** | | | |
| Depression | 0.4% | 5.8% | p = 0.003 |
| Diabetes | 6.0% | 15.8% | p = 0.003 |
| Hypertension | 49.4% | 62.5% | p = 0.02 |
| **DVT Prophylaxis** | 98.7% | 99.2% | ns |
| Fondaparinux | 0.4% | 15.8% | p < 0.001 |
| Aspirin | 86.0% | 62.5% | p < 0.0001 |
| Warfarin | 11.1% | 10.8% | ns |
| Enoxaparin | 11.1% | 42.5% | p < 0.0001 |
| Clopidogrel | 2.1% | 3.3% | ns |
| Heparin | 0.4% | 3.3% | ns |

# Results

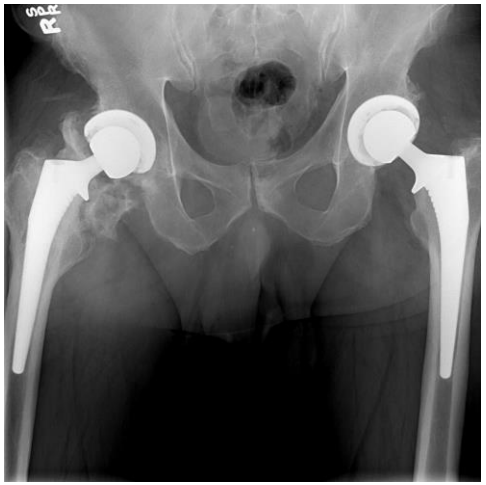
| Variable | Comparison | Odds Ratio (95% CI) | p-value |
|---|---|---|---|
| **Approach** | **Anterior approach** | **0.36 (0.13, 0.96)** | **0.041** |
| **DVT prophylaxis** | Fondaparinux | 0.92 (0.11, 7.53) | 0.94 |
| | **Aspirin** | **0.25 (0.09, 0.68)** | **0.0064** |
| | **Warfarin** | **4 (1.32, 12.5)** | **0.014** |
| | Enoxaparin | 2.38 (0.86, 6.67) | 0.096 |
| | **Clopidogrel** | **7.1 (1.6, 33.3)** | **0.009** |

**Odds ratios for developing clinically significant heterotopic ossification**

# Discussion

- Patients who underwent DAA were significantly less likely to develop clinically significant (Brooker Grade 3 or Grade 4) HO when compared to posterior approach
- Reasoning: DAA depends more on intermuscular planes for dissection which ultimately incites less local trauma
- Tippets et al, 2014:
  - Retrospective radiographic review of the incidence of HO in **236 DAA THAs** performed by 3 different surgeons in 2 different institutions
  - **Overall incidence of HO following DAA was 41.5% (8.1% Brooker grade 3 and 1.3% Brooker grade 4).**
  - Conclusion: DAA does not protect against the development of HO when compared to other surgical approaches

*Tippets DM, Zaryanox AV, Burke WV, et al. Incidence of Heterotopic ossification in Direct Anterior Total Hip Arthroplasty: A Retrospective Radiographic Review. J Arthorplasty 2014*



# Conclusion

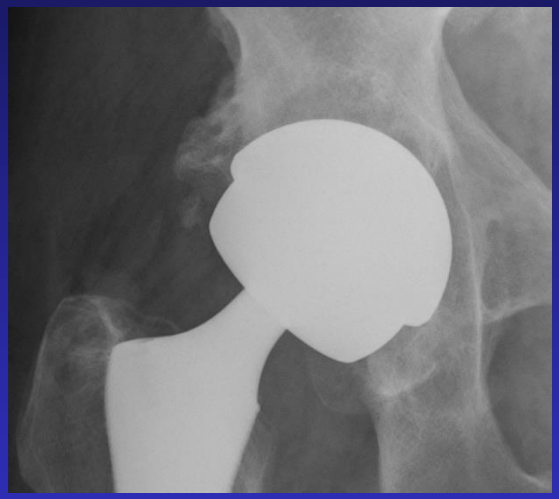
- This study expands the limited data available on the incidence of HO following DAA THAs
- This may be instructive when approaching THA candidates with conditions that predispose them to the development of HO, such as hypertrophic OA or ankylosing spondylitis

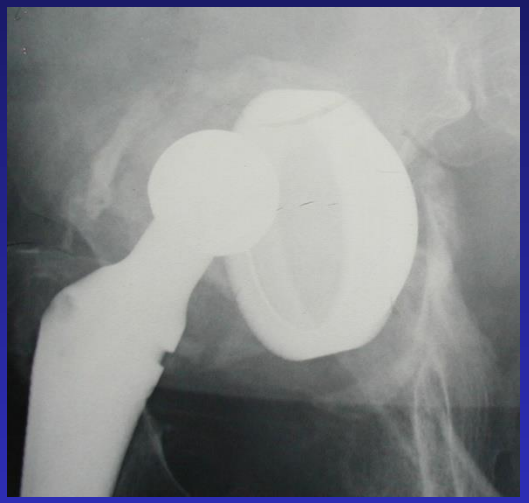
# Limitations

- Retrospective review
- Patients were not randomized to surgical approach arms of study
- Observer bias. Observer not blinded to surgical approach

# Thank you

# Complications are not Increased after MoM Acetabular Revision Compared to MoP Acetabular Revision






**Thorsten M. Seyler, MD, PhD**
**Colin T. Penrose, BS, BA**
**Samuel S. Wellman, MD**
**Michael P. Bolognesi, MD**
**Paul F. Lachiewicz, MD**

**Duke University** **Department of Orthopaedic Surgery**

# Disclosures

**Dr Lachiewicz**
- **Board member: Hip Society, OST**
- **Publications: JSOA, J Arthroplasty**
- **Royalties: Innomed**
- **Speakers bureau: Mallinckrodt, Pacira**
- **Consultant: Gerson Lehrman, Guidepoint Global, Mallinckrodt, Pacira**
- **Institutional research support: Zimmer**

**Dr Seyler**
- **Publications: Open Bone Journal; Bone & Joint Research; Heraeus**
- **Consultant: TJO; PerSys Medical**

**Dr Bolognesi**
- **Board member: EOA, AAHKS**
- **Stock: Amedia**
- **Publication: Arthroplasty Today**
- **Royalties, Research support: Biomet, Zimmer**
- **Consultant: TJO, Kinamed, Zimmer**

**Dr Wellman**
- **Publication: J Arthroplasty**
- **Consultant: TJO, Zimmer**
- **Research support: Biomet, Stryker, Zimmer**

**Mr Penrose: none**

# Isolated Revision of Acetabular Component

- Decreased blood loss, surgical time, and complications compared to both component
- Risk of dislocation:  up to 20%
- Metal-on-metal (MoM) revisions reported to have greater risk of complications, due to adverse local tissue reaction

MOM pseudotumor

Jones, Lachiewicz. JBJS 2004
Lawless et al. Clin Orthop 2010
Wyles et al. Clin Orthop 2014

# Study questions

1. Are there demographic differences in patients undergoing revision for failed MoM compared to MoP bearing surfaces?
2. Are there differences in early medical or wound complications after isolated acetabular revision of MoM compared to MoP ?
3. Are there differences in the frequency of dislocation, deep infection, and re-revision based on the original bearing surface?

# Materials and Methods

- Review of 100 % Medicare database; PearlDiver®
- MoM THA, then acetabular revision: 474 hips (474 pts)
- MoP THA, then acetabular revision: 672 hips
- 2005-2010 cohorts, complications tracked until 2012
- Minimum follow-up time: 2 years
  - 30-day, 90-day, 1-year, 2-year, and overall
- ICD-9 and CPT codes

Bozic, Lau et al. J Arthroplasty 2012

# Demographics

- Gender
- Age by range

  <65, 65-69, 70-74, 75-79, 80-84, >85
- Charlson Comorbidity Index

Charlson et al. J Chronic Diseases 1987
Schmolders et al. Int Orthop. 2015

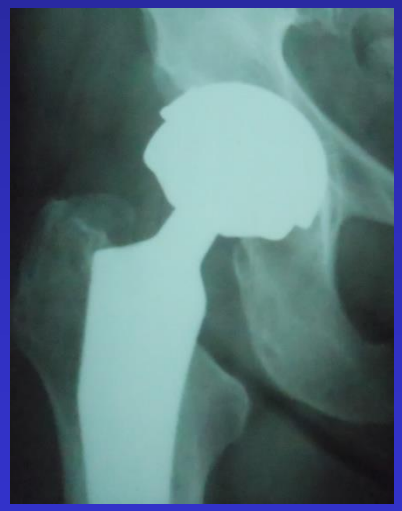
# Complications

**Early medical/wound:**

- DVT
- Myocardial infarction
- Heart failure
- UTI
- Bleeding
- Anemia
- Wound complication
- Cellulitis
- Transfusions

**Major surgical:**

- Dislocation
- Deep infection
- Re-revision



# Statistical Analyses

- **Chi-square test** (p-value <0.05 for significance)
- Values between 1-10 not provided by database,

  estimated to be 5 **Fisher's exact test**
- **Odds ratios** (OR), **95% Confidence intervals** (CI)

Acknowledgement: Dr Cindy Green Duke CRU

# Results
# Demographics: Gender

- **Higher proportion of females than males in the MoP acetabular revision cohort**

| Characteristic | Isolated acetabular revision of MoM | | Isolated acetabular revision of MoP | | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|---|
| Number of Patients | 474 | | 672 | | | | |
| *Gender* | | | | | | | |
| Female | 289 | 60.97% | 452 | 67.26% | 0.760 | 0.595-0.971 | 0.028 |
| Male | 174 | 36.71% | 208 | 30.95% | 1.294 | 1.009-1.658 | 0.042 |
| Unknown | 14 | 2.95% | 12 | 1.79% | 1.674 | 0.767-3.652 | 0.191 |

# Results
# Demographics: Age

- Higher proportion of older patient groups in the MoP than MoM acetabular revision cohort

| Characteristic | Isolated acetabular revision of MoM | | Isolated acetabular revision of MoP | | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|---|
| Number of Patients | 474 | | 672 | | | | |
| Less than 65 | 86 | 18.14% | 94 | 13.99% | 1.363 | 0.990-1.876 | 0.057 |
| 65-69 | 95 | 20.04% | 97 | 14.43% | 1.486 | 1.088-2.028 | 0.012 |
| 70-74 | 110 | 23.21% | 149 | 22.17% | 1.061 | 0.801-1.404 | 0.68 |
| 75-79 | 99 | 20.89% | 146 | 21.73% | 0.951 | 0.713-1.268 | 0.733 |
| 80-84 | 53 | 11.18% | 112 | 16.67% | 0.629 | 0.443-0.894 | 0.009 |
| 85 and over | 25 | 5.27% | 66 | 9.82% | 0.511 | 0.318-0.823 | 0.005 |
| Unknown | 14 | 2.95% | 12 | 1.79% | 1.674 | 0.767-3.652 | 0.191 |

# Results
# Charlson Comorbidity Index

- Identical mean and median CCI
- MoP had larger range

| Characteristic | Isolated acetabular revision of MoM | Isolated acetabular revision of MoP |
|---|---|---|
| **Number of Patients** | **474** | **672** |
| Mean | 7 | 7 |
| Median | 6 | 6 |
| Std Dev | 4.17 | 5.40 |
| Range | 1-35 | 1-59 |

# Results

## Early Medical/Wound Complications

- No differences in VTE, wound complications
- Blood transfusions more common in revisions of MoP

| Complication | MoM # (%) | MoP # (%) | OR | 95% CI | p-value |
|---|---|---|---|---|---|
| DVT | 15 (3.16) | 26 (3.87) | 0.812 | (0.425-1.55) | 0.527 |
| PE | 5* (1.05) | 5* (0.74) | 1.422 | (0.409-4.94) | 0.577 |
| Myocardial infarction | 5* (1.05) | 16 (2.38) | 0.437 | (0.159-1.201) | 0.099 |
| Heart Failure | 40 (8.44) | 61 (9.08) | 0.923 | (0.608-1.401) | 0.707 |
| Urinary Tract Infection | 72 (15.19) | 109 (16.22) | 0.936 | (0.674-1.299) | 0.691 |
| Bleeding complications | 22 (4.64) | 33 (4.91) | 0.942 | (0.542-1.638) | 0.834 |
| Postoperative anemia | 178 (37.55) | 237 (35.27) | 1.104 | (0.865-1.409) | 0.428 |
| Wound complications | 13 (2.74) | 16 (2.38) | 1.156 | (0.551-2.427) | 0.701 |
| Cellulitis | 35 (7.38) | 66 (9.82) | 0.732 | (0.477-1.123) | 0.152 |
| Transfusions | 147 (31.01) | 250 (37.20) | 0.759 | (0.591-0.974) | 0.030 |

# Results
## Hip Dislocation

- **No difference in dislocation after isolated acetabular revision between MoM and MoP**

  **76 of 474 MoM 16.03% vs**

  **118 of 672 MoP 17.56% at 2 years**

| Complication | Time points | MoM # (%) | MoP # (%) | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|
| Dislocation | 30 day | 16 (3.38) | 23 (3.42) | 0.986 | 0.515-1.887 | 0.965 |
| | 90 day | 27 (5.70) | 32 (4.76) | 1.208 | 0.714-2.045 | 0.481 |
| | 1 year | 65 (13.71) | 99 (14.73) | 0.920 | 0.656-1.289 | 0.628 |
| | 2 year | 76 (16.03) | 118 (17.56) | 0.897 | 0.654-1.229 | 0.498 |
| | overall | 87 (18.35) | 137 (20.39) | 0.878 | 0.651-1.184 | 0.393 |

# Results

## Deep Infection

- No difference in deep infection after isolated acetabular revision between MoM and MoP

| Complication | Time points | MoM # (%) | MoP # (%) | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|
| Deep Infection | 30 day | 5* (1.05) | 15 (2.23) | 0.467 | 0.169-1.294 | 0.134 |
| | 90 day | 11 (2.32) | 26 (3.87) | 0.590 | 0.289-1.207 | 0.144 |
| | 1 year | 32 (6.75) | 63 (9.38) | 0.700 | 0.449-1.090 | 0.113 |
| | 2 year | 46 (9.70) | 73 (10.86) | 0.882 | 0.598-1.302 | 0.527 |
| | overall | 58 (12.24) | 95 (14.14) | 0.847 | 0.597-1.202 | 0.352 |

# Results
## Re-revision

- No difference in re-revision after isolated acetabular revision between MoM and MoP

| Complication | Time points | MoM # (%) | MoP # (%) | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|
| Re-revision | 30 day | 11 (2.32) | 18 (2.68) | 0.863 | 0.404-1.845 | 0.704 |
| | 90 day | 16 (3.38) | 29 (4.32) | 0.775 | 0.416-1.443 | 0.42 |
| | 1 year | 62 (13.08) | 96 (14.29) | 0.903 | 0.640-1.273 | 0.56 |
| | 2 year | 82 (17.30) | 121 (18.01) | 0.953 | 0.699-1.297 | 0.758 |
| | overall | 105 (22.15) | 148 (22.02) | 1.007 | 0.759-1.337 | 0.959 |

# Study Limitations

- Administrative database reliant on coders
- No path or operative reports, or radiographs
- Length of follow Up minimum 2 yr
  - 8 year database
- HIPPA compliance
  - No exact data when numbers >0 and <11

Bozic, Bashyal et al. Clin Orthop 2013

# Study Strengths

- Medicare database contains 100% of inpatient and outpatient administratively coded data
- Large cohort sizes (474 MoM, 672 MoP)

# Discussion
## Cohort demographics

- MoP revision patients were more likely to be female and in older age groups

- Surgical selection bias or increased failure of MoM in younger, male patients? Both reasons ?

Lombardi et al. Clin Orthop 2015

# Discussion
## Early Complications

- Higher rates of blood transfusion in MoP revision cohort despite no difference in anemia or bleeding complication codes
- Lower transfusion threshold in population skewed toward older females?

# Discussion
## Hip dislocation

- High rate of dislocation in both cohorts but no difference between the isolated acetabular revisions of MoM and MoP

- Near the upper range of published reports for isolated acetabular revision
- No data on head sizes used

Jones and Lachiewicz J Bone Joint Surg 2004

# Discussion
## Deep Infection

- High rate of deep infection in both groups (9.70% MoM vs 10.86% MoP)
- Similar deep infection rate (8.1%) at 3 year mean follow up reported after revision of MoM at one institution
- No difference between revisions of MoM and MoP

Wyles et al. Clin Orthop 2014

# Discussion
## Re-revision

- Rates of re-revision were also very high in both cohorts
- But no statistically significant difference based on the original bearing surface

# Conclusions

## Isolated Acetabular Revision of MoM and MoP components

- High rates of dislocation, deep infection, and re-revision in **both cohorts**
- No differences between cohorts in complications
- Greater risk of transfusion in MoP cohort
- Additional follow-up required (?multi-center study)

# Dual Mobility Liners For Revision Total Hip Arthroplasty Decrease Early Postoperative Instability

Angerame, M, Mesko D, Gajewski N, Klika A, Frangiamore S, Molloy R, Springer B, Higuera C

Cleveland Clinic Foundation, Cleveland, OH
OrthoCarolina, Charlotte, NC
Carolinas Medical Center, Charlotte, NC

Carolinas Medical Center
Carolinas HealthCare System

OrthoCarolina

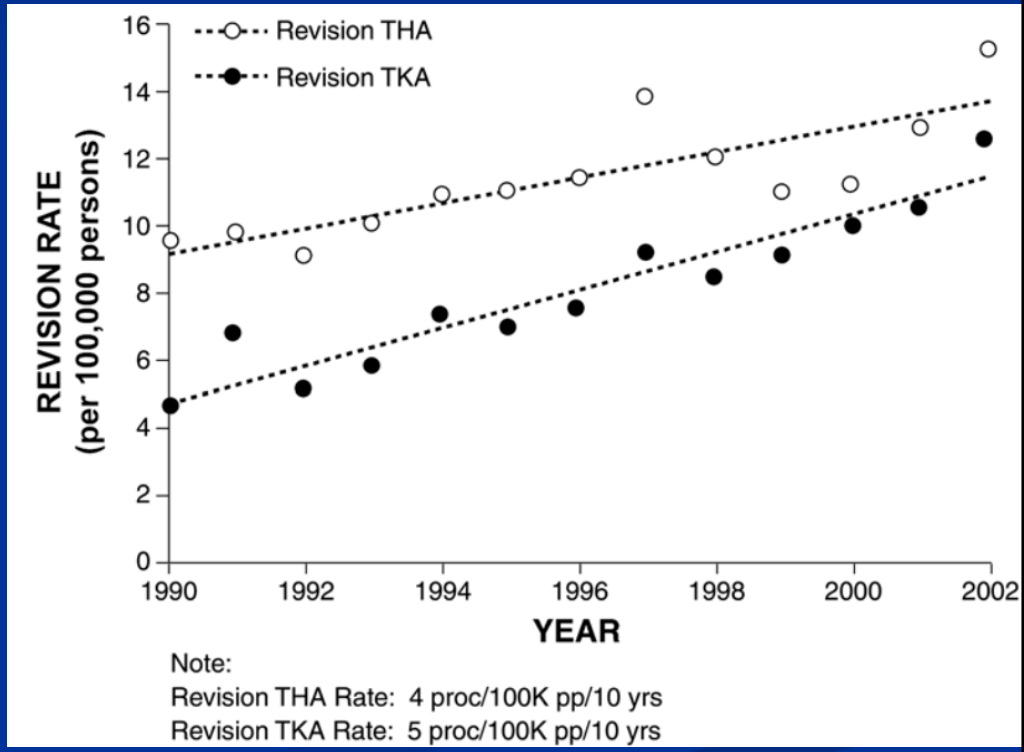
Cleveland Clinic

# Disclosure

- None of the authors have received anything of interest relative to this investigation.

# Revision Total Hip Arthroplasty

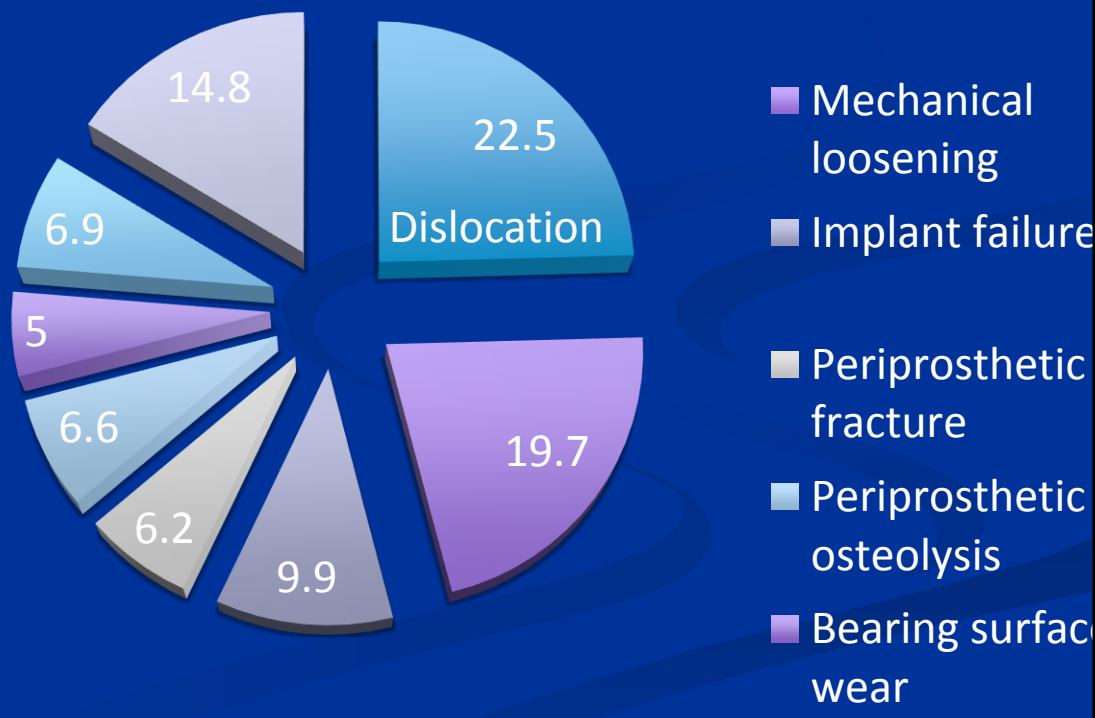
- Revision burden for THA
  - 17.5% from 1990-2002
  - Primary THA- increase 69%
  - Revision THA- increase 79%
- Cost
  - 1% decrease in rTHA burden
  - Could save $42.5-$112.6 million




Kurtz et al. Prevalence of Primary and Revision Total Hip and Knee Arthroplasty in the United States From 1990 Through 2002. JBJS (87A)7:1487-97

# Epidemiology of Revision THA

- Dislocation
  - One of the leading causes of revision
  - Reported as high as 28%
- Risk factors:
  - Revision THA
  - Abductor deficiency
  - AVN, EtOH, Hip Fracture
  - Neuromuscular Disorders
  - Obesity

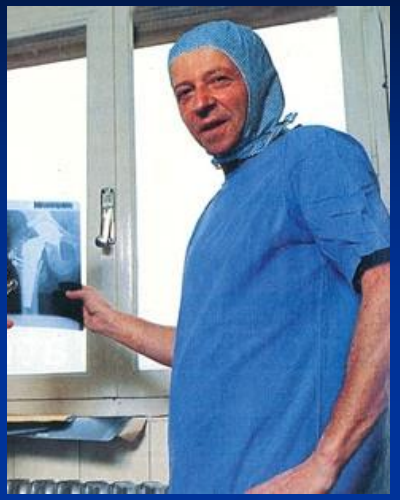



Bozic et al. The Epidemiology of Revision Total Hip Arthroplasty in the United States. JBJS 2009;91:128-33

# Enhancing Stability in High Risk Patients

- Optimize component position
- Surgical approach
- Minimize extra-articular impingement
- Maximize femoral offset
- Large diameter femoral heads
  - Risk polyethylene fatigue

# Enhancing Stability in High Risk Patients



Gilles Bousquet (1936-1996)

- Dual-Mobility Bearings
- Approved for use in U.S. in 2009
  - Developed dual-articulating design
  - Maintains principle of increased jump-distance
  - Maintains principle of thick, highly cross-linked polyethylene

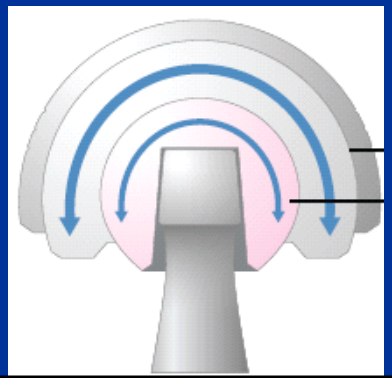


**Figure 1:** Modular Dual Mobility X3 (MDM) mobile bearing system. (Stryker, Mahwah, New Jersey

# Purpose

- To evaluate early dislocation rates and complications in patients who underwent rTHA
  - With the Modular Dual Mobility X3 (MDM)

**Figure 1:** Modular Dual Mobility X3 (MDM) mobile bearing system. (Stryker, Mahwah, New Jersey

# Methods

- Retrospective chart review at 2 high-volume centers
  - rTHAs with MDM X3 between 2011 and 2015
  - Minimum follow-up of 90 days
- Indications for revision surgery:
  - Infection
  - Pain
  - Recurrent instability
  - Aseptic loosening
  - Avascular necrosis
  - Arthrodesis take down
  - Periprosthetic fracture
  - Component malposition

# Methods

- Primary Outcome
  - Dislocation rate
  - Other complications
    - Fracture
    - Infection
- Secondary Outcomes
  - Demographic data
- Statistics performed using JMP 11 software (Cary, NC)

# Results

- Sex: 44% Male, 56% Female
- Avg age: 65 ± 15 years
- Avg ASA: 2.80
  - ASA in post-op instability compared to stable hips (3.3, p=0.03)
- Mean number of revisions: 1.16
- Mean follow-up: 555 ± 327 days
- MDM off-label use
  - 48/118 rTHA (40.6%)

# Results

Primary Outcomes

- 20 of 118 rTHA (14.5%) sustained complications
  - 17 patients
- Overall Dislocation Rate 5.9% (7 of 118)
  - 5 cases of early dislocation (4.2%)
    - 1 intraprosthetic dislocation (0.8%)
  - No significance of off-label use
  - Only 1 of 7 pts with dislocations were revised to MDM for instability

# Results

- Aseptic Loosening
  - 2 (1.7%)
- Infection
  - 8 (6.8%)
- Periprosthetic fracture
  - 2 (1.7%)

# Discussion

- Dislocation remains a problem in the early postoperative period in revision THA
- Use of the dual mobility components in revision surgery shows encouraging results
  - Early postoperative instability rate of 5.9%
    - vs current literature with rTHA early postop dislocation rates as high as 28%

# Discussion

- Further study in patient risk factors for dislocation following rTHA is needed
  - To best select candidate for dual mobility liners
  - Dual mobility vs Constrained Liner
- Longer follow up is needed
  - Adverse events
    - Polyethylene wear etc
    - Long-term stability

# Thank You

# Nasal decolonization of *S. Aureus* Reduces the Risk of Surgical Site Infections in TJA Patients: A Meta-Analysis

**Bryce A. Van Doren, MPA, MPH**
Susan M. Odum, PhD
Mason G. Haber, PhD
Michael D. Baratz, MD
Bryan D. Springer, MD

UNC CHARLOTTE
OCRI ORTHOCAROLINA RESEARCH INSTITUTE
UMASS
Tufts UNIVERSITY
OrthoCarolina HIP & KNEE CENTER

# Disclosures

- I have no conflicts of interest to disclose.

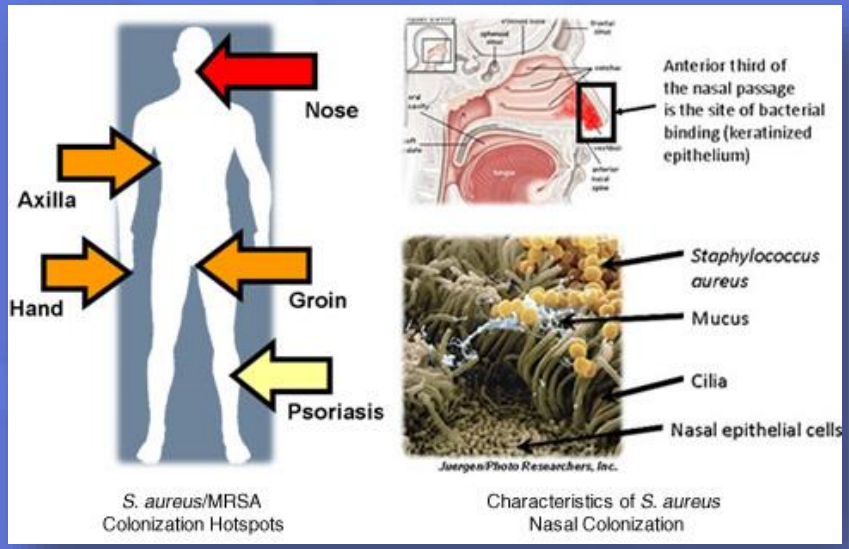
# Introduction

- Surgical Site Infections (SSIs)[1-4]
  - One of the most serious complications of total joint arthroplasty (TJA)
  - Occurs in 1-2% of TJA patients
  - ↑ Morbidity and mortality
    - **(~3% mortality… 2-11x risk of death)**
  - $560 million in annual health care expenditure



# Introduction

- *Staphylococcus aureus* (*S. aureus*)
  - Connection between nasal colonization by *S. aureus* and SSIs first established in 1959[6]
  - The majority of SSIs in TJA are caused by *S. aureus*[7-8]



# Introduction

- Nasal decolonization
  - To date, several single institution studies have been conducted to evaluate efficacy of MRSA screening to reduce SSI
  - Mixed results
  - SSI is a rare event and many studies are underpowered

Mixed Results (Examples):

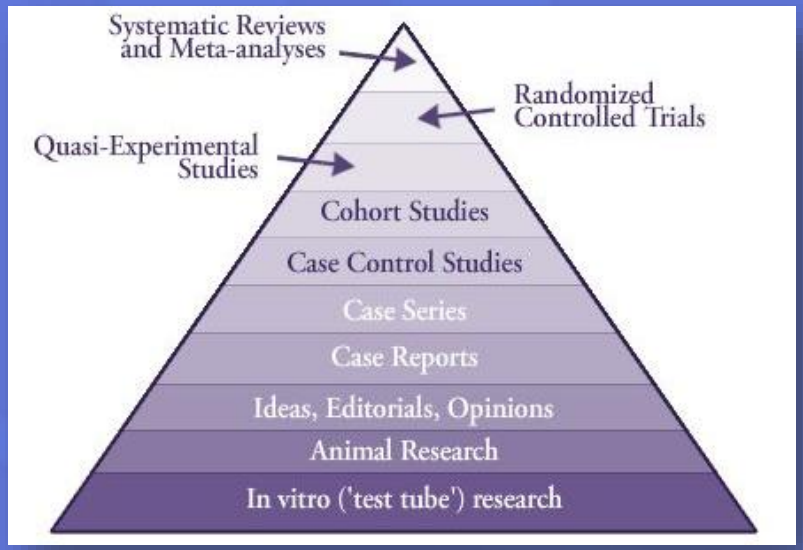
Wilcox 2003 – RR: 0.167 (0.064-0.437)
-Clear Reduction (Statistically Significant)

Pofahl 2009 – RR: 0.106 (0.006-1.880)
-Reduction (Not Statistically Significant)

Rao 2011 – RR: 1.419 (0.740-2.721)
-Increase in Risk (Not Statistically Significant)

# Research Question & Purpose

- Determine the efficacy of MRSA screening and decolonization to reduce SSIs in TJA patients using pooled data and meta-analysis methods

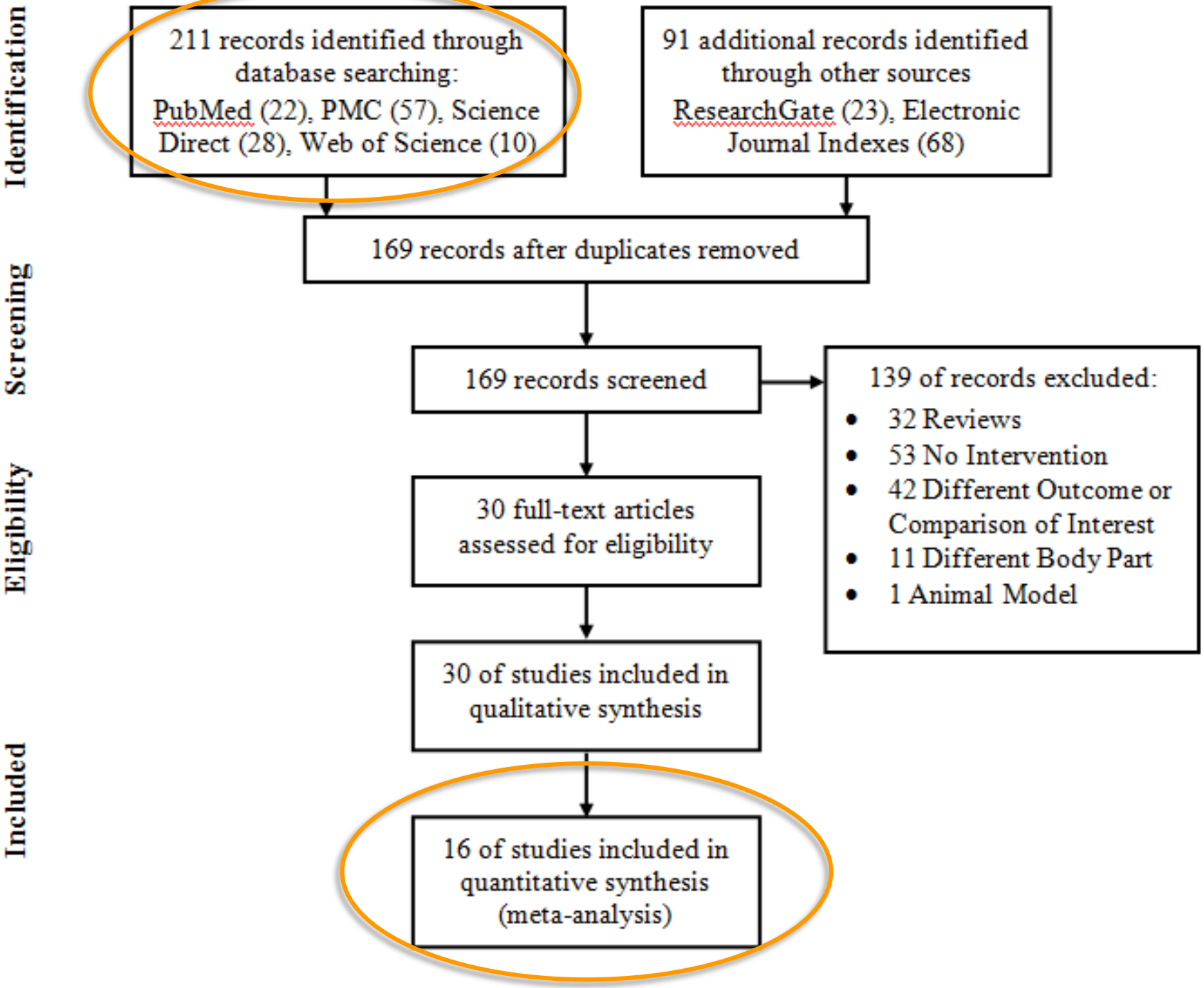


# Methods

- Performed **meta-analysis** on articles published between April 1999 and September 2015
  - Searched PubMed, PMC, Science Direct, and Web of Science
  - Additional searches of reference lists, electronic journal indices and ResearchGate

- Inclusion Criteria:

1. Active surveillance or empiric nasal decolonization with mupirocin (may also utilize chlorhexidine and/or targeted vancomycin decolonization in addition to mupirocin)
2. Patients underwent total joint arthroplasty
3. SSIs was reported as an outcome
4. Outcome was compared to concurrent or historical control group


Identification
Screening
Eligibility
Included
211 records identified through database searching: PubMed (22), PMC (57), Science Direct (28), Web of Science (10)
91 additional records identified through other sources ResearchGate (23), Electronic Journal Indexes (68)
169 records after duplicates removed
169 records screened
139 of records excluded:
32 Reviews
53 No Intervention
42 Different Outcome or Comparison of Interest
11 Different Body Part
1 Animal Model
30 full-text articles assessed for eligibility
30 of studies included in qualitative synthesis
16 of studies included in quantitative synthesis (meta-analysis)

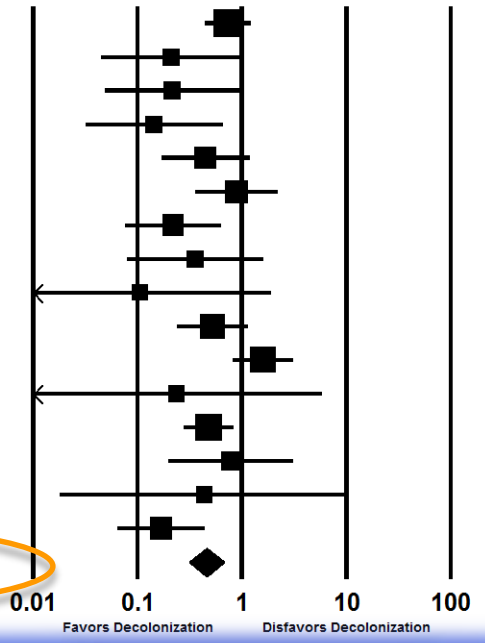
# Results

- Collectively, the **16 studies** represent 56,711 patients undergoing TJA
  - 43.5% (n=24,669) decolonization protocol group
  - 52.16% (n=20,418) untreated controls
- 14 studies – active surveillance ± selective decolonization (92.7% of treated patients)
  - 6 Studies → PCR
  - 8 Studies → Cell Culture
- 2 studies – universal decolonization (no screening)

# Results

**Nasal decolonization resulted in a 54.6% decrease in the risk of SSI compared to controls (p<0.001)**

| Study name | Risk ratio | Lower limit | Upper limit | Z-Value | p-Value |
|---|---|---|---|---|---|
| Baratz 2015 | 0.734 | 0.442 | 1.218 | -1.198 | 0.231 |
| Barbero Allende 2015 | 0.209 | 0.045 | 0.961 | -2.011 | 0.044 |
| DeLucas-Villarrubia 2004 | 0.214 | 0.049 | 0.931 | -2.054 | 0.040 |
| Gottschalk 2014 | 0.144 | 0.032 | 0.647 | -2.528 | 0.011 |
| Hacek 2008 | 0.447 | 0.171 | 1.169 | -1.641 | 0.101 |
| Hadley 2010 | 0.881 | 0.358 | 2.170 | -0.275 | 0.784 |
| Lamplot 2015 | 0.219 | 0.076 | 0.626 | -2.832 | 0.005 |
| McDonald 2015 | 0.355 | 0.079 | 1.593 | -1.352 | 0.176 |
| Pofahl 2009 | 0.106 | 0.006 | 1.880 | -1.530 | 0.126 |
| Rao 2008 | 0.524 | 0.240 | 1.143 | -1.623 | 0.104 |
| Rao 2011 | 1.590 | 0.830 | 3.049 | 1.397 | 0.162 |
| Sankar 2005 | 0.237 | 0.010 | 5.783 | -0.883 | 0.377 |
| Schweizer 2015 | 0.481 | 0.282 | 0.819 | -2.695 | 0.007 |
| Sousa 2015 | 0.781 | 0.200 | 3.043 | -0.356 | 0.722 |
| van Rijen 2012 | 0.437 | 0.018 | 10.447 | -0.512 | 0.609 |
| Wilcox 2003 | 0.167 | 0.064 | 0.437 | -3.651 | 0.000 |
| | 0.454 | 0.312 | 0.661 | -4.119 | 0.000 |



# Results

- No difference between active surveillance and selective decolonization versus universal decolonization (p=0.120)
- Addition of chlorhexidine did not further reduce risk of SSIs (p=0.165)
- Addition of vancomycin did not further reduce risk of SSIs (p=0.522)
- Cell culture and PCR performed equally well (p=0.133)

# Discussion

- This meta-analysis demonstrated that nasal decolonization is an effective tool for prevention of SSIs in TJA
  - 54.6% reduction in risk of SSI
- No difference between active surveillance/ selective decolonization and universal protocols
- These programs do not eliminate SSIs entirely
  - Issues with patient compliance and recolonization

# References


1. Lindeque B, Hartman Z, Noshchenko A, Cruse M. Infection after primary total hip arthroplasty. Orthopedics. 2014 Apr;37(4):257-65.
2. Kane P, Chen C, Post Z, Radcliff K, Orozco F, Ong A. Seasonality of infection rates after total joint arthroplasty. Orthopedics. 2014 Feb;37(2):e182-6.
3. Rasouli MR, Restrepo C, Maltenfort MG, Purtill JJ, Parvizi J. Risk factors for surgical site infection following total joint arthroplasty. J Bone Joint Surg Am. 2014 Sep 17;96(18):e158.
4. Baratz MD, Hallmark R, Odum SM, Springer BD. Twenty Percent of Patients May Remain Colonized With Methicillin-resistant Staphylococcus aureus Despite a Decolonization Protocol in Patients Undergoing Elective Total Joint Arthroplasty. Clinical orthopaedics and related research. 2015 Feb 18.
5. Weinstein HJ. The relation between the nasal-staphylococcal-carrier state and the incidence of postoperative complications. New Engl J Med. 1959;260(26):1303-8.
6. Noskin GA, Rubin RJ, Schentag JJ, Kluytmans J, Hedblom EC, Smulders M, et al. The burden of *Staphylococcus aureus* infections on hospitals in the United States: an analysis of the 2000 and 2001 Nationwide Inpatient Sample Database. Arch Intern Med. 2005 Aug 8-22;165(15):1756-61.
7. Saadatian-Elahi M, Teyssou R, Vanhems P. *Staphylococcus aureus*, the major pathogen in orthopaedic and cardiac surgical site infections: a literature review. Int J Surg. 2008;6(3):238-45.

# Acknowledgements


- **Special thanks to my co-authors**

UNC CHARLOTTE

OCRI
ORTHOCAROLINA
RESEARCH INSTITUTE

University of
Massachusetts
UMASS Medical School

Tufts Medical Center

OrthoCarolina
HIP & KNEE CENTER

# The Effect of a Door Alarm on Decreasing Operating Room Traffic in Total Joint Arthroplasty

Scott Eskildsen MD
Daniel Del Gaizo MD
UNC Orthopaedics

# Disclosures

- None

UNC ORTHOPAEDICS

# Background

- Altering surrounding parameters like opening the operating room doors and foot traffic can change the dynamics of unidirectional airflow pattern
- This may increase air turbulence, which has been associated with a faster spread of airborne organisms
- Door Openings also correlate with increased foot traffic

UNC ORTHOPAEDICS

# Background

- Door Openings in Orthopaedic Trauma Surgery

-Andersson et al. **Am. J. of Infection Control** 2012

| Necessary door openings | n | Semi-necessary door openings | n | Unnecessary door openings | n |
|---|---|---|---|---|---|
| Expert consultations (eg, senior surgeons, expert nurses, or anesthesia) | 40 | Surgical team members entering after incision or leaving before closure | 76 | Logistic reasons planning next or other operation | 30 |
| Instruments or other material needed | 137 | Lunch and coffee breaks | 108 | Social visits | 45 |
| | | | | No detectable reasons | 93 |
| Total | 177 | | 184 | | 168 |
| | | | | | 529 |

UNC ORTHOPAEDICS

# Background

-Smith et al. ***Journal of Arthroplasty*** *2013*

- 2 sterile basins placed in the OR inside and out of the laminar flow

- Increased contamination with Door Openings

-Andersson et al. **Am. J. of Infection Control** 2012

- strongly positive correlation between the total contamination and total traffic flow per operation

UNC ORTHOPAEDICS

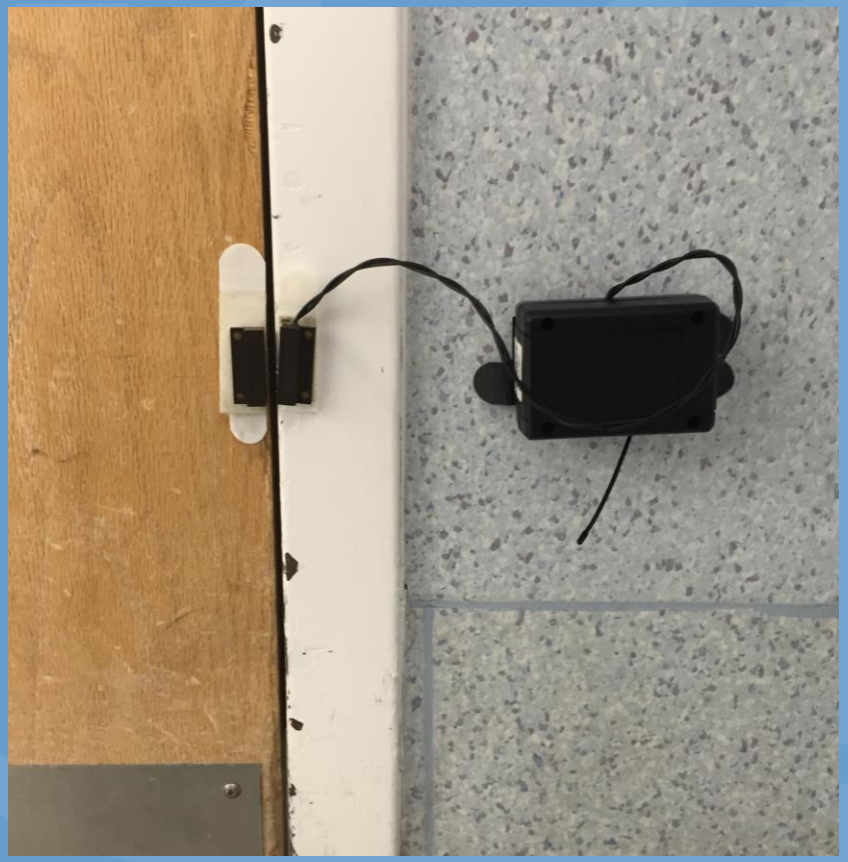
# Methods

- Door Counter alone for 50 cases
- Alarm placed for an Additional 50 cases
  - 2 beat chime, every 5 seconds
- Only primary arthroplasty cases were recorded
- Data recorded consecutively over 39 operative days

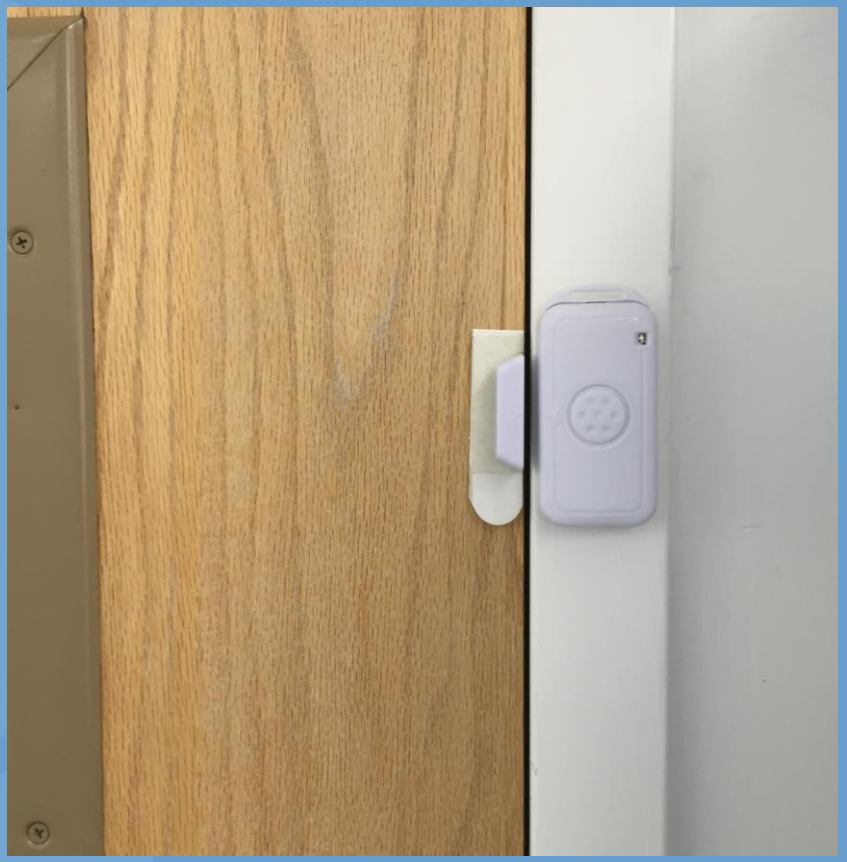
UNC ORTHOPAEDICS

# Methods

## Door Counter

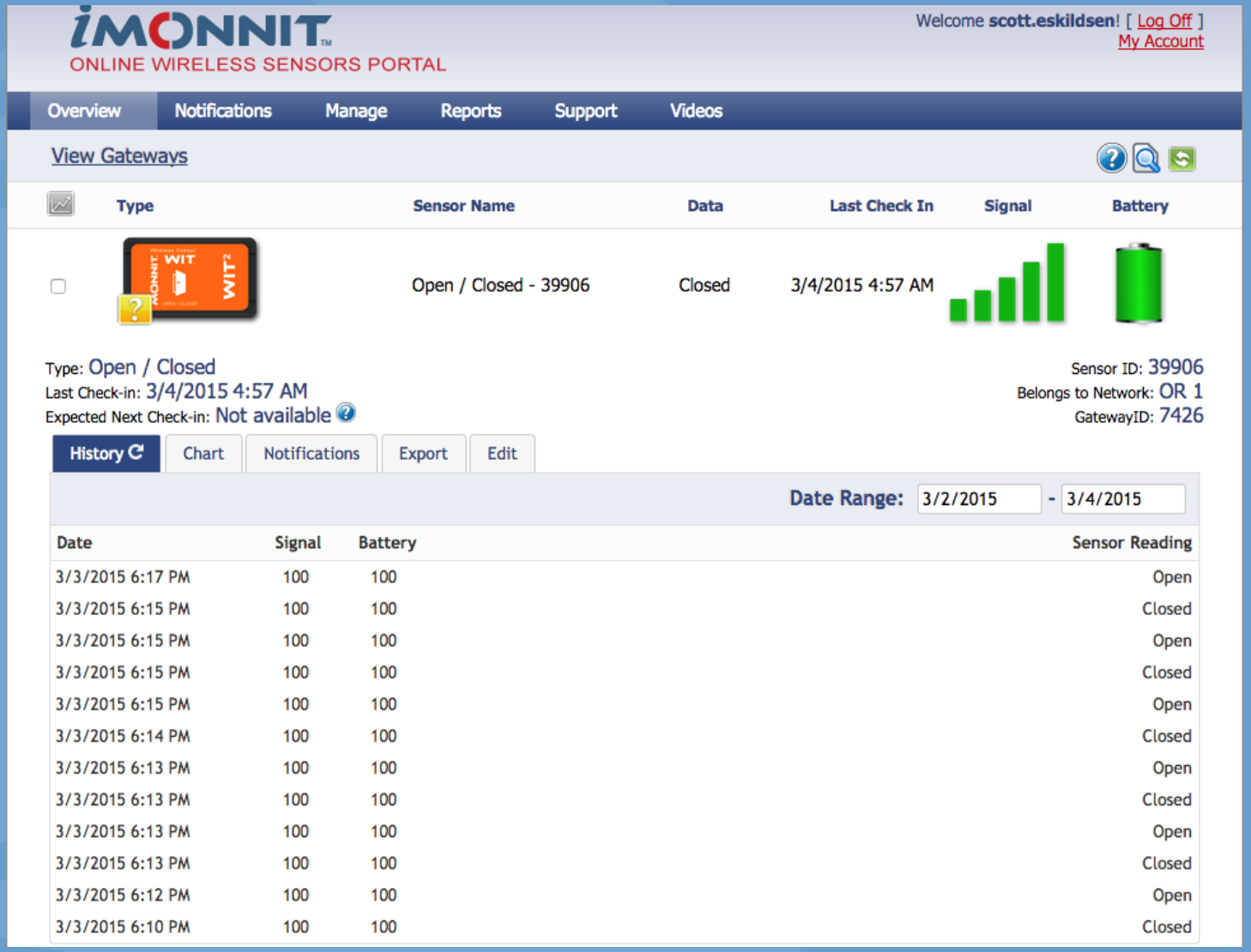


## Door Alarm



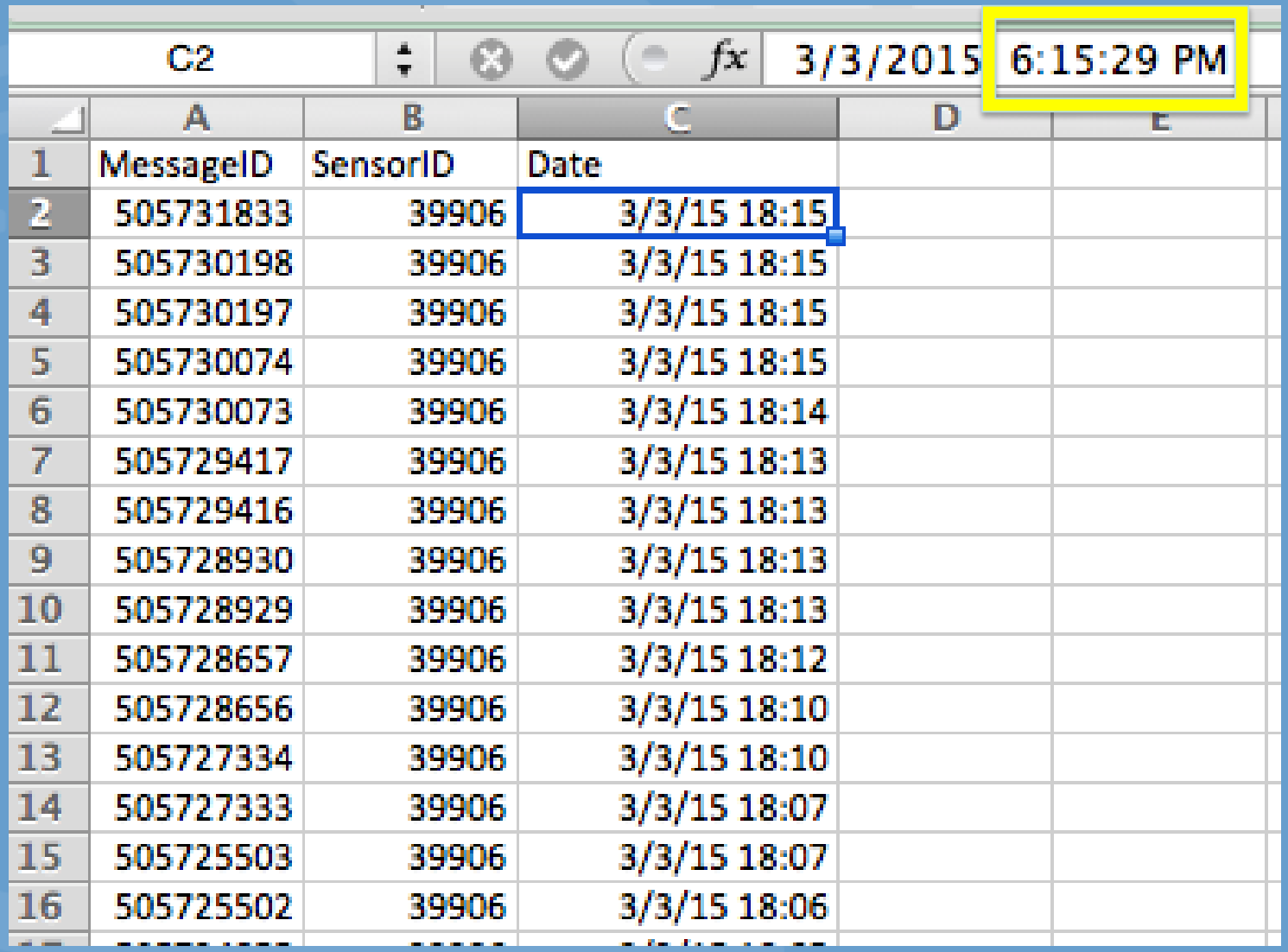
UNC ORTHOPAEDICS

# Methods




UNC ORTHOPAEDICS

# Methods

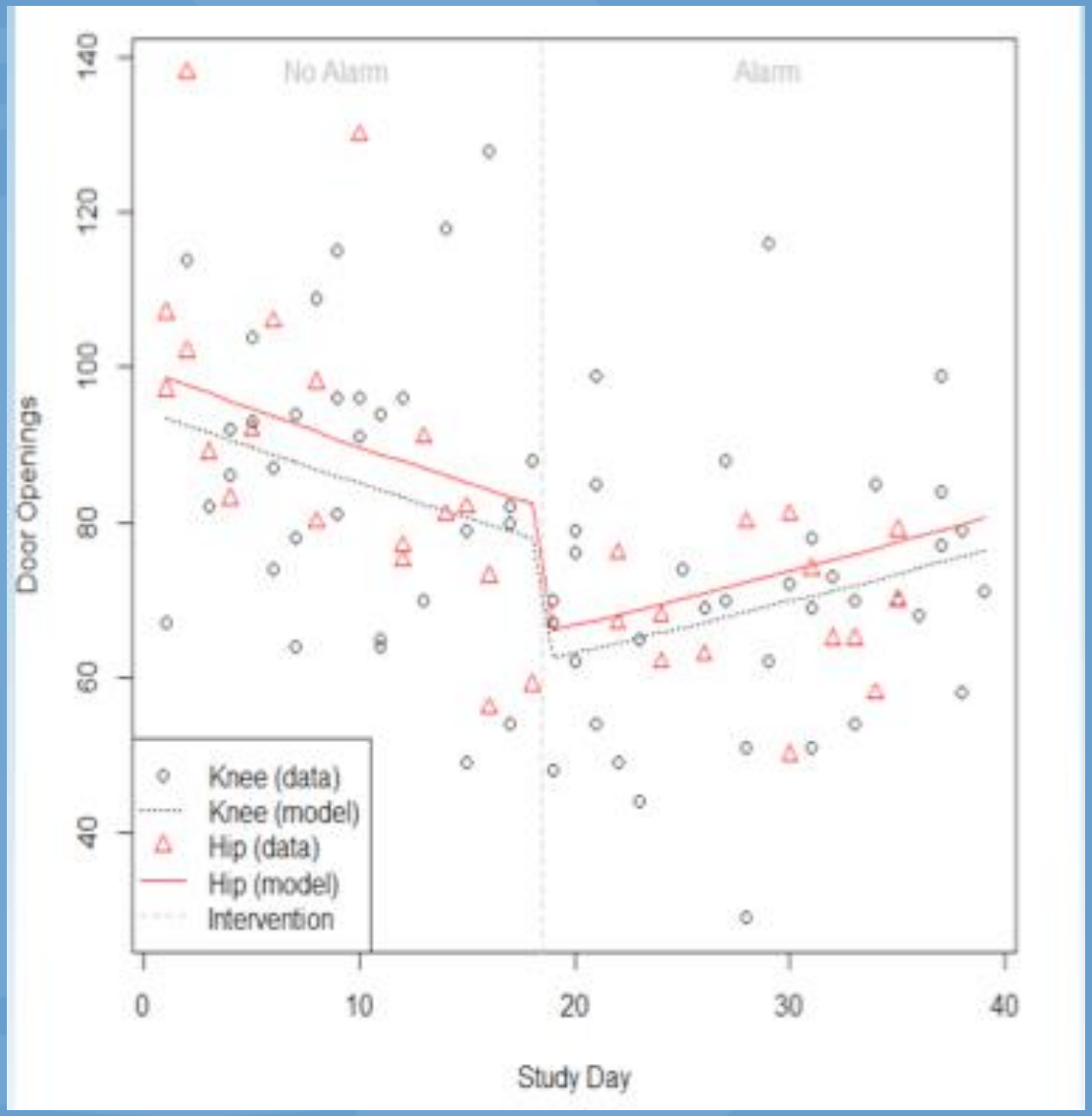


C2 | 3/3/2015 6:15:29 PM

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | MessageID | SensorID | Date | | |
| 2 | 505731833 | 39906 | 3/3/15 18:15 | | |
| 3 | 505730198 | 39906 | 3/3/15 18:15 | | |
| 4 | 505730197 | 39906 | 3/3/15 18:15 | | |
| 5 | 505730074 | 39906 | 3/3/15 18:15 | | |
| 6 | 505730073 | 39906 | 3/3/15 18:14 | | |
| 7 | 505729417 | 39906 | 3/3/15 18:13 | | |
| 8 | 505729416 | 39906 | 3/3/15 18:13 | | |
| 9 | 505728930 | 39906 | 3/3/15 18:13 | | |
| 10 | 505728929 | 39906 | 3/3/15 18:13 | | |
| 11 | 505728657 | 39906 | 3/3/15 18:12 | | |
| 12 | 505728656 | 39906 | 3/3/15 18:10 | | |
| 13 | 505727334 | 39906 | 3/3/15 18:10 | | |
| 14 | 505727333 | 39906 | 3/3/15 18:07 | | |
| 15 | 505725503 | 39906 | 3/3/15 18:07 | | |
| 16 | 505725502 | 39906 | 3/3/15 18:06 | | |

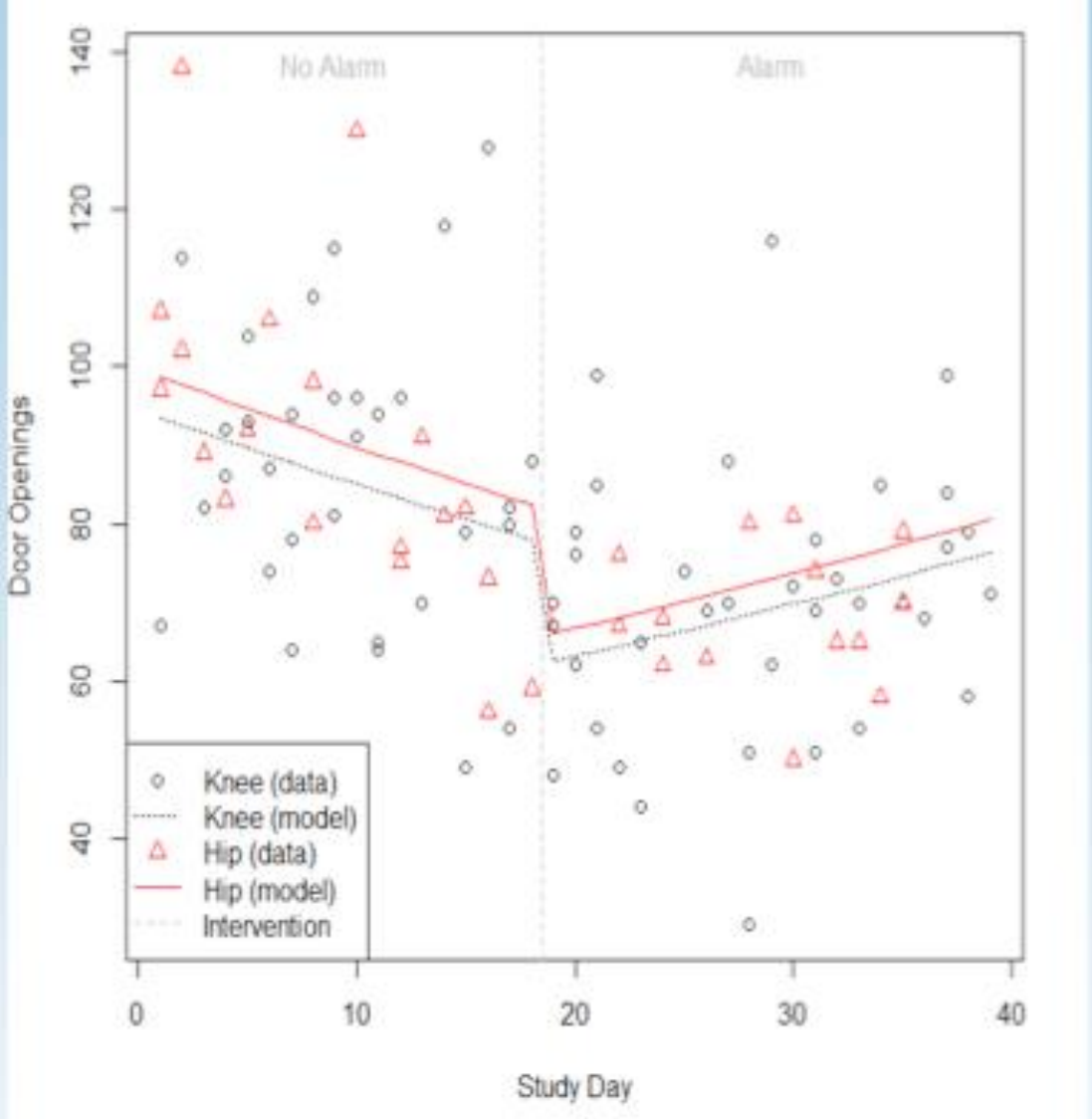
UNC ORTHOPAEDICS

# Results




UNC ORTHOPAEDICS

# Results




Increases at a factor of 1.01 openings/min

UNC ORTHOPAEDICS

# Results

| Group | No Alarm | Alarm | P Value |
|---|---|---|---|
| Openings per Minute | 0.53 ± 0.09 | 0.42 ± 0.09 | P<0.001 |
| Seconds Open per Opening | 9.84 ± 0.63 | 9.35 ± 0.59 | P<0.001 |
| Minutes Door Open per Case | 14.45 ± 3.32 | 10.81± 2.3 | P<0.001 |
| Percentage of Case Door Ajar | 8.65% ± 1.5 | 6.63% ± 1.6 | P<0.001 |
| Case Minutes | 167.68 ± 25.12 | 165.98 ± 24.55 | P=0.733 |

UNC ORTHOPAEDICS

# Limitations

- Not Randomized
- Staff Awareness
- Did we discourage necessary openings?
- Balance between effectiveness and mutiny

UNC ORTHOPAEDICS

# Conclusions

- The use of an alarm can decrease door openings and ultimately the risk for surgical site infection.
- The effect is subject to tolerance and may not result in the elimination of unnecessary operating room traffic long-term.
- Continuing education and awareness may be necessary to maintain these results.

UNC ORTHOPAEDICS