Periprosthetic Joint Infection
Coming of a Tsunami

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Rothman Institute at Thomas Jefferson University
I (and/or my co-authors) have something to disclose.

Detailed disclosure information is available via:

“My Academy” app;

Printed Final Program; or

AAOS Orthopaedic Disclosure Program on the AAOS website at
http://www.aaos.org/disclosure
Infection is a terrible problem
Unrecognized Genius

- 1880 - First wrist arthroplasty
- 1890 - First Ivory Knee replacement into knee of a 17 year old girl
- 14 joints that year including a hip
- Reported on five cases

INFECTION

... ailments of human will be treated by artificial materials......
Unrecognized Genuis

- Themistokles Gluck (1853-1942)
- Balkan War surgeon – bone defect
- Intramedullary fixation
- Biocompatibility
- Plate fixation (mandible)
- Bone cement (So much earlier than Haboush (1953), Wiltse (1957), Charnley (1964))
- 1880- vascular graft (Alexis Carrel who was given the Noble Prize in 1912)
Unrecognized Genuis
Periprosthetic Joint Infection

1979s Sir John Charnley

...joint sepsis will be the major hurdle in our way in the future..
High morbidity
PJI Challenges

Infection kills
PJIs worse than some cancers.
Mortality after TJA
Medicare Study

Are We Winning or Losing the War with PJI: Trends in PJI and Mortality Risk for the Medicare Population

- Steven M. Kurtz PhD
- Edmund Lau MS
- Min-Sun Son PhD
- Ellen T. Chang ScD
- Werner Zimmerli MD
- Javad Parvizi MD
Summary of Findings

- PJI incidence has not improved over time
- Mortality risk after PJI has decreased over time
- The 5-year overall survival of PJI patients is comparable to two of the most common cancers

- **TKA:** 72%
- **Breast cancer:** 73%
- **Prostate cancer:** 79%
Infection is on the rise
Infected Revisions 2001-2010

Burden

48,000 revisions for infection in 2017

Kurtz, S, Parvizi J JOA 2012
$1.8 billion

Kurtz, S, Parvizi J JOA 2012
Prevention is best
Pubmed Publications for PJI by Year

Obtained using the keyword “periprosthetic joint infection”
Prevention of Surgical Site Infection
Periprosthetic Joint Infection

- Prevention of SSI Guidelines are in development
Core Section
- Antimicrobial prophylaxis
- Glycemic control
- Normothermia
- Tissue oxygenation
- Skin Preparation
- S. aureus colonization
- Surgical check list
CDC Guidelines for SSI Prevention

- Arthroplasty
  - Transfusion
  - Immunosuppression
  - Anticoagulation
  - Surgical attire
  - Surgical technique
  - Anesthesia
  - Environment
  - Biofilm
Evidence Based Pyramid

1. Systematic Reviews and Meta-analyses
2. Randomized Controlled Double Blind Studies
3. Cohort Studies
4. Case Control Studies
5. Case Series
6. Case Reports
7. Ideas, Editorials, Opinions
8. Animal research
9. In vitro ('test tube') research
Much of what we have is based on thin science, if any at all
International Consensus Meeting
Philadelphia, August 2013
Question: What are significant risk factors for development of surgical site infection (SSI) or periprosthetic joint infection (PJI) after elective total joint arthroplasty (TJA)?

Consensus: The risk factors for SSI or PJI include history of previous surgery, uncontrolled diabetes mellitus, malnutrition, morbid obesity, active liver disease, active renal disease, excessive smoking (>one pack per day), excessive alcohol consumption (>40 units per week), intravenous drug abuse, recent hospitalization, extended stay in a rehabilitation facility, male gender, diagnosis of post-traumatic arthritis, inflammatory arthropathy, prior surgical procedure in the affected joint, and severe immunodeficiency.

Delegate Vote: Agree: 94%, Disagree: 4%, Abstain: 2%.
Optimize Host
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Patient Optimization

- **Systemic or local infection**
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Control Nidus

- GI/GU (urine)
- Skin
- Nails
- Oral cavity
No role for routine dental clearance

Ask about oral disease
Is routine dental clearance necessary?

- 358 elective TJA
  - With dental clearance
- 218 hip fracture (THA or hemiarthroplasty)
  - No dental clearance

No statistical difference was found between the two groups in terms of early postoperative infection

Lampley A et al. JOA, 2014
Risk factors

- Tobacco use,
- Poor flossing habits,
- Hx of tooth extraction,
- Narcotic use,
- Lack of a dentist visit within 12 months.

Tokarski AT et al. The Journal of Arthroplasty 2014
PJTI Consensus

- No role for routine urine screening
- Ask about urinary symptoms
PJI Consensus

- Routine urine screening
- 4.58 wound infections in non-prosthetic knee operations
- Cost = $1,500,000 per wound infection prevented

Patient Optimization

- Systemic or local infection
- **Immunosuppressive state**
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Inflammatory Arthritis

- Increases risk of infection/other complications
- Inherent disease state
- DMARDS/steroids
- Hazard ratio = 1.96

Pulido L et al CORR 2009
Moucha et al JBJS 2011
## Table 3  Baseline patient characteristics

<table>
<thead>
<tr>
<th>Number of patients with prosthetic joints</th>
<th>nbDMARD (n=659)</th>
<th>Anti-TNF (n=2689)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure time (years)*</td>
<td>1954</td>
<td>12 959</td>
</tr>
<tr>
<td>Events</td>
<td>6</td>
<td>41</td>
</tr>
<tr>
<td>Incidence prosthetic joint SA/1000 pyrs (95% CI)</td>
<td>3.1 (1.1 to 6.7)</td>
<td>3.2 (2.3 to 4.3)</td>
</tr>
<tr>
<td>Adjusted HR (95% CI)</td>
<td>Ref</td>
<td>1.2 (0.4 to 3.4)</td>
</tr>
</tbody>
</table>

*Patients were included in this analysis only if they had a prosthetic joint in situ.

Anti-TNF, anti-tumour necrosis factor; nbDMARD, non-biological disease-modifying antirheumatic drug; pyrs, patient years.
Patients on DMARDs have serious infections

Giles JT et al Arthritis Care Res 2006
DMARDs and PJI

2005 BSR
• Biologics stopped 2-4 weeks prior to procedure
• and restarted after wound healing

2012 ACR
• Topic not addressed
CDC Guidelines for SSI Prevention

- Arthroplasty
  - Transfusion
  - Immunosuppression
  - Anticoagulation
  - Surgical attire

No recommendation
Question: Should disease-modifying agents be stopped prior to elective TJA?

Consensus: Yes. Disease-modifying agents should be stopped prior to elective TJA; however, the timing of drug discontinuation should be based on specific medication and the individual patient.

Delegate Vote: Agree: 92%, Disagree: 5%, Abstain: 3%.
<table>
<thead>
<tr>
<th>Medication</th>
<th>Half life</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonsteroidal Anti-inflammatory drugs (NSAIDs)</td>
<td>2-17 hours</td>
<td>Discontinue therapy within 1 week prior to surgery</td>
</tr>
<tr>
<td>Methotrexate</td>
<td>0.7 to 5.8 hours</td>
<td>Discontinue therapy within 1 week prior to surgery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Continue therapy 2 weeks after surgery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patients with renal dysfunction, hold 2 weeks prior to surgery</td>
</tr>
<tr>
<td>Sulfasalazine</td>
<td>5 hours</td>
<td>Discontinue therapy prior to 1 week before surgery</td>
</tr>
<tr>
<td>Azathioprine</td>
<td>7.6 hours</td>
<td></td>
</tr>
<tr>
<td>Efalunomide</td>
<td>2 weeks</td>
<td>Hold for 6 weeks prior to surgery</td>
</tr>
<tr>
<td>Hydroxychloroquine</td>
<td>1-2 months</td>
<td>Continue therapy up to and including the day of surgery</td>
</tr>
<tr>
<td>Biological Response Modifiers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infliximab</td>
<td>4.3 days</td>
<td>Hold for at least 1.5 weeks prior to surgery</td>
</tr>
<tr>
<td>Rinancet</td>
<td>8-10 days</td>
<td>Hold for 3 weeks prior to surgery</td>
</tr>
<tr>
<td>Golimumab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golcizumab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abatacept</td>
<td>12-14 days</td>
<td>Hold for 1 month prior to surgery</td>
</tr>
<tr>
<td>Adalimumab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bortezomib</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rituximab</td>
<td>21 days</td>
<td>Hold for 2 months prior to surgery</td>
</tr>
<tr>
<td>Folate agents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allopurinol</td>
<td>1-2 hours</td>
<td>Discontinue therapy within 1 week prior to surgery</td>
</tr>
<tr>
<td>Colchicine</td>
<td>26-32 hours</td>
<td></td>
</tr>
<tr>
<td>Probenecid</td>
<td>26-32 hours</td>
<td></td>
</tr>
</tbody>
</table>
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Diabetes

- Increases risk of infection
- Other complications

Marchant MH et al JBJS 2009
Jamsen E et al Eur J Intern Med 2010
Mravoic J Diabets Sci Technol 2011
American Diabets Association 2013
Core Section
- Antimicrobial prophylaxis
- Glycemic control
- Normothermia
- Tissue oxygenation
- Skin Preparation
- S. aureus colonization
- Surgical checklist

Maintain under 200 mg/dL 10 mmol/L

International Consensus
- 200 mg/dL
- Contraindication in presence of ulcer
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- **Chronic disease** (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Chronic State

- Renal
- Liver
- Chronic anemia

Olsen M et al JBJS 2008
HICPAC and CDC Guideline 2013
Viola J et al J Arthroplasty 2015
Anemia

- Increases all time complications
  - Mortality
  - SSI/PJI

Viola J et al J Arthroplasty 2015
Anemia
Rothman Study

- 13,593 TJA
- 2,580 anemic patients
- Multivariate analysis (OR = 2.11)
- Cardiovascular complication 26.5% vs 11.8%
- Infection 4.5% vs 1.12%
- Mortality 0.2% vs 0.08%

Viola J et al J Arthroplasty 2015
Anemia

• Chronic conditions
  (renal failure, liver disease, etc.)

• Malnurished

• Blood transfusion
  “immunomodulation”

• Oxygenation/wound healing
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- **Malnutrition**
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Malnutrition

- Direct correlation with adverse outcome

Gherini S et al Clin Orthop 1993
Lavernia C et al J Am Coll Nutr 1999
Malnutrition
Definition

- WHO definition
- Four components of metabolic syndrome:
  - Albumin (normal 3.5-5.0 g/dL)
  - Pre-albumin (normal 15-35 mg/dL)
  - Transferrin (normal 204-360 mg/dL),
  - Lymphocyte count (normal 800-2000/mm³) [10]
Malnutrition

Rothman Study

- Prospective study
- 2,161 TJA
- Overall incidence 8.5%
- Complication 12 vs 2.9% (p<0.0001)
- Hematoma formation, infection, renal, cardiovascular

Huang R et al J Arthroplasty 2013
Paradoxical malnutrition
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Obesity

Issues

More complications
Obesity Trends* Among U.S. Adults  
BRFSS, 1991  
(*BMI ≥30, or ~ 30 lbs overweight for 5’4” woman)
Obesity Trends* Among U.S. Adults

BRFSS, 2001

(*BMI ≥30, or ~ 30 lbs overweight for 5’4” woman)

Mokdad et al  JAMA 2003
Metabolic Syndrome

Definition

- WHO definition
- Four components of metabolic syndrome:
  - Obesity (BMI > 30 kg/m²)
  - Diabetes
  - Hypertension
  - Dyslipidemia
Metabolic syndrome has been indicated as a risk factor of morbidity following TJA.

Gandhi R et al. *J. Rheumatol*. 2009

Patients with uncontrolled vs. controlled diabetes are at an increased risk of morbidity and mortality following TJA.

Complications
Parvizi et al. JOA 2008

Percentage of Patients

Uncontrolled  Controlled

P.E.  Hema.  Wound  PJI  DVT  Disloc.  PpFx.  Renal  UTI  Cardiac  Cardiac  S.B.O.
Is there a limit?
No limit determined
Literature Review

Obesity increases risk for complication

BMI > 40 Kg/m²

Workgroup of AAHKS J Arthroplasty 2013
Philadelphia

- Fattest Population in the Nation
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Beware of these Patients

- Pain everywhere
- Affective disorder
Parvizi’s Case

- 380 lb
- 5’ 1”
Affective Disorder

- Increases incidence of infection

Kiecolt-Glaser J Psychosom Res 2002
Leonard BE. Prog Neuro-Psychopharmacology 2001
Bozic K Clin Orthop 2012
Depression affects immune system

- Inflammatory cytokines (IL-6)
- ACTH and cortisol

Kiecolt-Glaser J Psychosom Res 2002
Leonard BE. Prog Neuro-Psychopharmacology 2001
Depression and Infection

- Self neglect (hygiene)
- Malnutrition
- Chronic disease

Parvizi J et al JBJS 2003
Rezapooy M J Arthroplasty 2015
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Smoking increases the risk of infection

Heavy smoking (>20 per day)

Cessation reduces the risk

6-8 weeks prior to surgery

Singh J Arth Care Res 2011
Argintar E et al J AAOS 2012
Matar W et al JBJS 2010
Smoking increases the risk of infection

- Heavy smoking (>20 per day)
- Cessation reduces the risk
- 6-8 weeks prior to surgery

Singh J Arth Care Res 2011
Argintar E et al J AAOS 2012
Matar W et al JBJS 2010
Smoking increase the risk of PJI

- Metabolic effects are concerning

- Most studies find smoking to confer an increased risk of infection or wound complications
Metabolic Effects

- Reduced cutaneous blood flow
- Soft-tissue oxygenation and aerobic metabolism
- Carbon monoxide
- Platelet aggregation causing micro-thrombi and decreased perfusion
- Nicotine negatively modulates T-cell function
Peersman, et al, CORR 2001

Retrospective review of 6489 TKA patients, 113 infections (16 superficial, 97 deep)

Smoking was a significant risk factor for infection (p=0.01)
Duchman, et al, JBJS 2015

- NSQIP database study, 78,191 primary TKA and THA patients
- 30-day complications
- Current smokers had a higher rate of wound complications (1.8%) compared with former smokers and nonsmokers (1.3% and 1.1%, respectively; p < 0.001).
Singh, et al, Arthritis Care and Research 2011
- VASQIP database study, primary THA/TKA patients
- Current smokers were significantly more likely than never-smokers to have surgical site infections (odds ratio [OR] 1.41, 95% CI 1.16-1.72)
Moller et al, JBJS(Br) 2003

- Retrospective review of 825 primary THA/TKA patients
- Smoking was a significant risk factor for wound complications (23% vs 8%, \( P < 0.001 \)) and an independent predictor of wound complication (OR 3.2, 95% CI 1.8-6, \( P = 0.001 \))
- Wound complications = hematoma, culture + infection, subfascial collection
Our Data (Unpublished)

- Retrospective
- 15,275 patients (17,394 primary TJA)
- Current smokers were significantly more likely than non-smokers to undergo reoperation for infection (1.2% vs. 0.69%, OR 1.8, 95% CI: 1.1-2.9, p=0.02)
- No significant differences were noted between current smokers and former smokers with regards to reoperation for infection (1.24% vs. 0.87%, p=0.33)
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Alcohol Consumption and Infection

- Excessive alcohol consumption (>40 units/week)
- Risk of infection/other complications
- Cessation reduces the risk (*Tonnesen H et al BMJ 1999*)
- 4 weeks prior to surgery

Aggarwal VK *J Arthroplasty* 2014
Azodi OS *JBJS-B* 2006
Harris AHJ *JBJS* 2011
Patient Optimization

- Systemic or local infection
- Immunosuppressive state
- Uncontrolled Diabetes/hyperglycemia
- Chronic disease (anemia, liver, renal, etc.)
- Malnutrition
- Obesity
- Affective disorders
- Smoking
- Excessive Alcohol consumption
- IV drugs/HIV
Drug Abuse and HIV

- Risk of infection
  
  *(Parvizi J et al J Arthroplasty 2003)*

- HIV-positive (14%)
- Drug abuse (25%)
- Both (40%)

*Lehman CR J Arthroplasty 2001*
CD4 count > 300
Low viral count

Aggarwal VK et al J Arthroplasty 2014

Retroviral therapy positive effect

Enayatollahi et al –Pending publication
Human Immunodeficiency Virus and Total Joint Arthroplasty: The Risk for Infection is Reduced

Mohammad Ali Enayatollahi¹ MD
Dermot Murphy², Mitchell G. Maltenfort¹PhD
Javad Parvizi¹ MD FRCS

¹Rothman Institute at Thomas Jefferson University, Philadelphia, PA
² Department of Orthopaedics, University of Limerick, Midlands Regional Hospital, Tullamore, Ireland
Epidemiology

- HIV was identified in 1983.
- Its socioeconomic and psychological burden continues to be a great challenge to global health
Epidemiology

- 39 million people had died of HIV since the beginning of the epidemic.
- As of 2013,
  - > 35 million people worldwide
  - > one million in the US

www.who.int/gho/hiv/en/
HIV in IRAN

- As of 2013, Estimated number of people (all ages) living with HIV 70,000 [47,000-110,000]
  
  http://www.who.int/gho/hiv/en/

- HIV rates have increased by 80% per year for the past decade.

- 75% of those infected are unaware of their status.

Lancet, vol382,2013
HIV and TJA

Why this study?

- The advent of HAART in 1997 changed the nature of HIV infection.
- In US, by 2015 >50% of all HIV infections will be >50 Y/O Cumminis et al 2014
- Musculoskeletal complications
  - Osteonecrosis of bone 45-fold
  - Osteopenia and osteoporosis insufficiency fractures including femoral neck fractures.

Triant et al 2008
Why this study?

- The demand for TJA in HIV patients is on the rise

- Treatment strategies and outcomes of TJA in HIV patients is controversial

- PJI rate in earlier studies: 50% Swensen et al 2012
  - Prior to HAART era
  - Comorbidities like hemophilia, IVDU

- PJI rate in recent studies is comparable to HIV-negative population Graham et al 2014, Capogna et al 2013

- Hemophilic patients were exposed to HIV through unscreened factor replacements between the years 1979 and 1985.
HIV and TJA

Present study

- Systematic review

- Study hypotheses:
  1. HIV patients without hemophilia have a lower rate of PJI than HIV patients with hemophilia after primary TJA.
  1. The use of HAART may reduce the rate of PJI
Our search strategy

130 articles identified on initial search of Medline and EMBASE databases

96 articles excluded after review of titles and abstracts
- Not concerned with TJA: 46
- Article in both databases: 15
- Review article: 15
- Hemophilia-only patients: 8
- Ankle/Elbow joint: 5
- Case reports: 4
- No data on PJ1 or HAART: 3

34 Full text articles reviewed

25 articles included for review

9 articles excluded after review of full text
- Article in both databases: 3
- Review articles: 2
- Case report: 2
- Elbow replacement: 1
- No data on PJ1 or HAART: 1
# Demographics of HIV patients with hemophilia

<table>
<thead>
<tr>
<th>Study</th>
<th>TJA number</th>
<th>PJI number</th>
<th>patients number</th>
<th>male number</th>
<th>follow up</th>
<th>Mean age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goddard et al(^a) 2010</td>
<td>17</td>
<td>1</td>
<td>16</td>
<td>Unclear</td>
<td>9.2 years (2-23)</td>
<td>43 (25-70)</td>
</tr>
<tr>
<td>Habermann et al(^b) 2008</td>
<td>33</td>
<td>2</td>
<td>41 in study overall</td>
<td>37</td>
<td>81 months (2-14 years)</td>
<td>46 (34-68)</td>
</tr>
<tr>
<td>Hicks et al(^c) 2001</td>
<td>91</td>
<td>17</td>
<td>Unclear</td>
<td>Unclear</td>
<td>5.7 years (0.1 – 20.8)</td>
<td>39 (22-60)</td>
</tr>
<tr>
<td>Lehman et al(^d) 2001</td>
<td>18</td>
<td>3</td>
<td>14</td>
<td>Unclear</td>
<td>62 months (24-152)</td>
<td>33 (25-48)</td>
</tr>
<tr>
<td>Norian et al(^e) 2002</td>
<td>40</td>
<td>4</td>
<td>29</td>
<td>Unclear</td>
<td>110 months (24-246)</td>
<td>33.7 (+/- 8.2)</td>
</tr>
<tr>
<td>Thomason et al(^f) 1999</td>
<td>12</td>
<td>4</td>
<td>12 (not useable)</td>
<td>Unclear</td>
<td>7.5 years</td>
<td>Unclear</td>
</tr>
<tr>
<td>Powell et al(^g) 2005</td>
<td>30</td>
<td>3</td>
<td>19</td>
<td>19</td>
<td>80 months (2-323)</td>
<td>33 (20-61)</td>
</tr>
<tr>
<td>Ragni et al(^h) 1995</td>
<td>34</td>
<td>8</td>
<td>34 (not useable)</td>
<td>Unclear</td>
<td>Unclear</td>
<td>36 (+/- 3.1)</td>
</tr>
<tr>
<td>Rodriguez et al(^i) 2011</td>
<td>21</td>
<td>2</td>
<td>21</td>
<td>Unclear</td>
<td>8.5 years (1-13)</td>
<td>36.5 (24-52)</td>
</tr>
<tr>
<td>Rodriguez et al(^j) 2007</td>
<td>19</td>
<td>1</td>
<td>19</td>
<td>Unclear</td>
<td>7.5 years (1-10)</td>
<td>31 (24-42)</td>
</tr>
<tr>
<td>Unger et al(^k) 1995</td>
<td>26</td>
<td>0</td>
<td>15</td>
<td>Unclear</td>
<td>6.4 years (1-9)</td>
<td>33 (25-42)</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>341</strong></td>
<td><strong>45</strong></td>
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</tbody>
</table>
# Demographics of HIV-infected patients without hemophilia

<table>
<thead>
<tr>
<th>Study</th>
<th>TJA number</th>
<th>PJI number</th>
<th>patients number</th>
<th>male number</th>
<th>Follow up</th>
<th>Mean age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capogna et al(^{11}) 2013</td>
<td>69</td>
<td>3</td>
<td>57</td>
<td>33</td>
<td>609 days</td>
<td>44.8</td>
</tr>
<tr>
<td>Chokocho et al(^{12}) 2013</td>
<td>15</td>
<td>0</td>
<td>12</td>
<td>Unclear</td>
<td>HIV patients not separated</td>
<td>47.1 (not useable)</td>
</tr>
<tr>
<td>Cammins et al(^{8}) 2014</td>
<td>8</td>
<td>0</td>
<td>7</td>
<td>3 (Not useable as operations not clear)</td>
<td>25 months (1-68 months)</td>
<td>35 (not useable)</td>
</tr>
<tr>
<td>Graham et al(^{12}) 2014</td>
<td>43</td>
<td>0</td>
<td>29</td>
<td>19</td>
<td>3 years, 6 months (5 months – 8 years and 2 months)</td>
<td>47 years, 7 months (21 months + 5 months)</td>
</tr>
<tr>
<td>Yoo et al(^{13}) 2010</td>
<td>5</td>
<td>0</td>
<td>3</td>
<td>16.6 months (4-37 months)</td>
<td>38.6 (not separated by operation)</td>
<td></td>
</tr>
<tr>
<td>Lim et al(^{15}) 2014</td>
<td>22</td>
<td>2</td>
<td>20</td>
<td>20</td>
<td>4.6 years (2-8.6 years)</td>
<td>49 (+/- 17.8)</td>
</tr>
<tr>
<td>Lubega et al(^{19}) 2009</td>
<td>18</td>
<td>0</td>
<td>18</td>
<td>Unclear</td>
<td>Unclear</td>
<td>52 (not useable)</td>
</tr>
<tr>
<td>Mahoney et al(^{14}) 2005</td>
<td>54</td>
<td>1</td>
<td>40</td>
<td>31</td>
<td>2.3 years (1-7 years)</td>
<td>44.4 (+/- 9.3)</td>
</tr>
<tr>
<td>Snir et al(^{35}) 2014</td>
<td>41</td>
<td>1</td>
<td>31</td>
<td>22</td>
<td>33 months (4-116)</td>
<td>49.6 (32-75)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>TJA number</th>
<th>PJI number</th>
<th>patients number</th>
<th>male number</th>
<th>Follow up</th>
<th>Mean age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tornero et al(^{36}) 2012</td>
<td>18</td>
<td>0</td>
<td>13</td>
<td>11</td>
<td>3.3 years (+/- 2.5)</td>
<td>44.3 (+/- 9.1)</td>
</tr>
<tr>
<td>Wang et al(^{37}) 2012</td>
<td>8</td>
<td>0</td>
<td>5</td>
<td>Unclear</td>
<td>38.6 months (4-84)</td>
<td>44.5 (36-54)</td>
</tr>
<tr>
<td>Falakassa et al(^{39}) 2014</td>
<td>32</td>
<td>0</td>
<td>24</td>
<td>17</td>
<td>14 months (1.5 - 60)</td>
<td>50 (31-74)</td>
</tr>
<tr>
<td>Issa et al(^{19}) 2013</td>
<td>44</td>
<td>2</td>
<td>34</td>
<td>23</td>
<td>7 years (4-11 years)</td>
<td>48 (Range 34-80)</td>
</tr>
<tr>
<td>Lehman et al(^{17}) 2001</td>
<td>4</td>
<td>0</td>
<td>na</td>
<td>na</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
<tr>
<td>TOTAL</td>
<td>381</td>
<td>9</td>
<td>293</td>
<td>71.3%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Incidence of PJI in HIV patients with and without HAART

<table>
<thead>
<tr>
<th>Author</th>
<th>Number of PJI/number of TJA on HAART (%)</th>
<th>Number of PJI/number of TJA not on HAART (%)</th>
<th>Total number of PJI/total number of TJA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capogna et al.¹⁹</td>
<td>2/54 (3.7)</td>
<td>1/15 (6.7)</td>
<td>3/69 (4.3)</td>
</tr>
<tr>
<td>Chokotho et al.²³</td>
<td>0/15 (0)</td>
<td>0/0 (0)</td>
<td>0/15 (0)</td>
</tr>
<tr>
<td>Cummins et al.⁸</td>
<td>0/8 (0)</td>
<td>0/0 (0)</td>
<td>0/8 (0)</td>
</tr>
<tr>
<td>Graham et al.⁷</td>
<td>0/43 (0)</td>
<td>0/0 (0)</td>
<td>0/43 (0)</td>
</tr>
<tr>
<td>Issa et al.⁵⁰</td>
<td>2/44 (4.5)</td>
<td>0/0 (0)</td>
<td>2/44 (4.5)</td>
</tr>
<tr>
<td>Yoo et al.⁵⁰</td>
<td>0/5 (0)</td>
<td>0/0 (0)</td>
<td>0/5 (0)</td>
</tr>
<tr>
<td>Lin et al.³⁴</td>
<td>2/21 (9.5)</td>
<td>0/1 (0)</td>
<td>2/22 (9)</td>
</tr>
<tr>
<td>Snir et al.⁵²</td>
<td>1/41 (2.4)</td>
<td>0/0 (0)</td>
<td>1/41 (2.4)</td>
</tr>
<tr>
<td>Tornero et al.⁴¹</td>
<td>0/18 (0)</td>
<td>0/0 (0)</td>
<td>0/18 (0)</td>
</tr>
</tbody>
</table>
Statistics

- conventional meta-analysis with an offset of 0.5
- “lme4” package in the R statistical analysis platform (R Foundation for Statistical Computing, Vienna, Austria)
## Results

<table>
<thead>
<tr>
<th>HIV WITHOUT HEMOPHILIA</th>
<th>TJA NUMBER</th>
<th>PJI NUMBER</th>
<th>MEAN AGE YEAR</th>
<th>F/U</th>
<th>MALE %</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV + HEMOPHILIA</td>
<td>381</td>
<td>9</td>
<td>46.9</td>
<td>1.5mo-11y</td>
<td>71.3</td>
</tr>
<tr>
<td>HIV + HEMOPHILIA</td>
<td>341</td>
<td>45</td>
<td>38.1</td>
<td>1-26 y</td>
<td>&gt;90</td>
</tr>
<tr>
<td>HEMOPHILIA</td>
<td>722</td>
<td>P&lt;0.0001</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

September 19
Results

- The rate of PJI in HIV-only group was 2.14% (95% CI 1.02%-4.53%).

- The rate of PJI in the HIV and hemophilia group was 11.88% (95% CI: 7.82%-17.63%).

- This difference was statistically significant (p<0.0001) with an odds ratio for hemophilia of 6.17 (95% CI: 2.68-14.23).
Results

- HAART was associated with fewer infections overall, with an odds ratio of 0.12 (95% CI: 0.03-0.44)
HIV and TJA

Results

Effect of HAART on the rate of PJI

- Capogna et al: 0.54 [0.05, 6.38]
- Chokotho et al: 0.03 [0.00, 4.03]
- Cummins et al: 0.06 [0.00, 7.50]
- Graham et al: 0.01 [0.00, 1.41]
- Issa et al: 0.06 [0.00, 3.63]
- Joon Yoo et al: 0.09 [0.00, 11.88]
- Lin et al: 0.38 [0.01, 12.25]
- Snir et al: 0.04 [0.00, 2.58]
- Tornero et al: 0.04 [0.00, 4.64]

RE Model: 0.12 [0.03, 0.44]
Concerns
Post op. morbidity and mortality in HIV patients is significantly related to:
- Malnourishment
- Wight loss
- Renal diseases
- Fluid imbalance

Lin et al 2013
Concerns

- Safe thresholds for CD4 and Viral load need to be determined.

- CD4 < 200 in trauma patients is associated with increased complications

Guild et al 2012
Limitations

- All studies were retrospective
- Demographics were insufficient
- Inconsistent patient-level data on CD4, viral load, and other comorbidities
Conclusion

- Rates of PJI after primary TJA in patients with HIV-only are not as high as those in patients with both HIV and hemophilia

- HAART and optimization of underlying comorbidities has appeared to lower the rate of PJI
HIV and TJA

Accepted as a poster presentation for the 2016 AAOS Annual Meeting 2016
Poster ID #p052
HIV and TJA

THANK YOU
Human Immunodeficiency Virus and Total Joint Arthroplasty: The Risk for Infection is Reduced

Enayatollahi MA, Murphy D, Maltenfort MG, Parvizi J. J Arthroplasty 2016
Beware of these Patients

- Pain everywhere
- Affective disorders!!
- Numerous previous operations!!
Do Not Operate on

40 year old comes with parents

More than 5 allergies including allergy to water

Sun glasses in the office

Bow-tie
How many cats is too many?
THANK YOU.