

2-2021

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Zachary S. Aman

Michael Yayac

Alexander J. Rondon

Timothy L. Tan

P. Maxwell Courtney

*See next page for additional authors*

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**Authors**

Zachary S. Aman, Michael Yayac, Alexander J. Rondon, Timothy L. Tan, P. Maxwell Courtney, and James J. Purtil

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**Sidney Kimmel  
Medical College™**  
at Thomas Jefferson University

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Zachary S. Aman, BA, Michael Yayac, MD, Alexander J. Rondon, MD, Timothy L. Tan, MD, P. Maxwell Courtney, MD, James J. Purtill, MD\*

> [J Arthroplasty](#). 2020 Aug 1;S0883-5403(20)30865-2. doi: 10.1016/j.arth.2020.07.072.

Online ahead of print.

## **Risk Factors and Effect of Acute Kidney Injury on Outcomes Following Total Hip and Knee Arthroplasty**

Michael Yayac <sup>1</sup>, Zachary S Aman <sup>2</sup>, Alexander J Rondon <sup>3</sup>, Timothy L Tan <sup>3</sup>, P Maxwell Courtney <sup>1</sup>, James J Purtill <sup>1</sup>

Affiliations + expand

PMID: 32839060 DOI: [10.1016/j.arth.2020.07.072](#)

THE JOURNAL OF  
ARTHROPLASTY





# Introduction

- **Acute Kidney Injury**
- Abrupt decrease in kidney function due to structural or functional damage<sup>1</sup>:
  - Several etiologies: ischemia, nephrotoxicity, obstruction, etc.
  - Known to significantly complicate clinical course and worsen outcomes in hospitalized patients
- **AKI After TJA**
  - 2- 15% of THA and TKA patients<sup>2</sup>
  - Potentially avoidable complication related to negative outcomes
  - longer LOS, increased readmission rates, and increased healthcare costs<sup>3</sup>
  - Can lead to CKD<sup>2</sup>
- **Risk Factors for AKI**
  - Increased age, CHF, postoperative hypotension, and hepatic failure<sup>4-6</sup>
  - In post-cardiac surgery patients, anemia has been reported to be a risk factor for AKI<sup>7-10</sup> → medullary hypoxia<sup>11</sup>
  - Gharaibeh et al reported that for every 5-kg/m<sup>2</sup> increase in BMI, patients had a 40% increase risk of AKI post-THA<sup>12</sup>



# Introduction

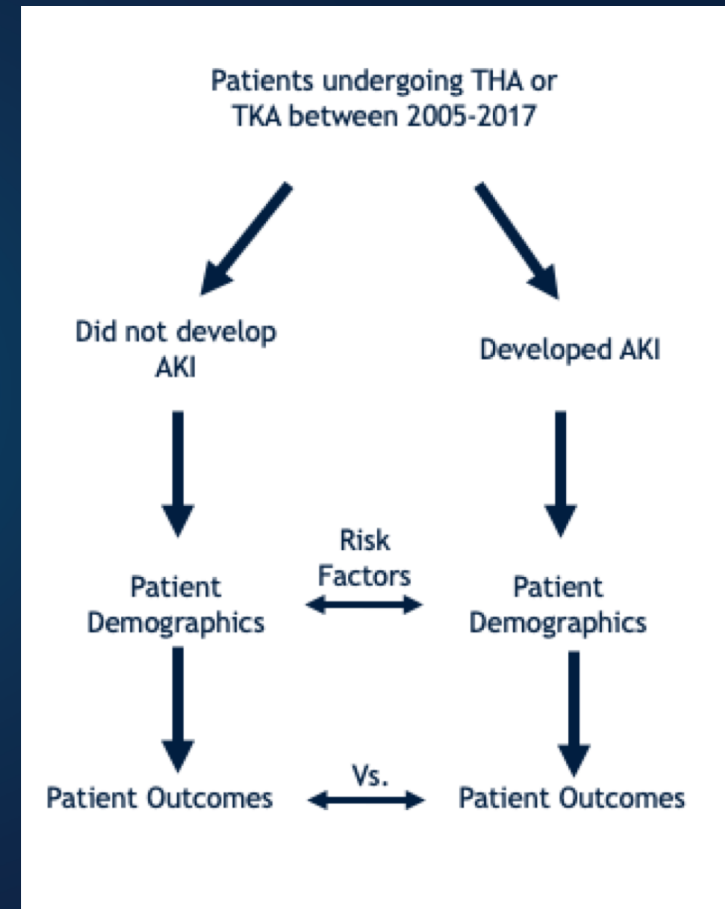
- There remains limited information regarding the association of modifiable risk factors and AKI post-TJA
  - Anemia, length of surgery, blood loss, antibiotics, etc.
- How can surgeons better identify and proactively mitigate modifiable risk factors of AKI?
  - Risk reduction can lead to improved outcomes and lower costs

# Purpose & Hypothesis

- **Purpose:**
  - 1) To determine the effect of AKI on short-term outcomes
  - 2) to identify risk factors for developing AKI following THA and TKA
- **Hypothesis:**
  - 1) AKI has significant adverse effects on short-term outcomes metrics including length of stay, discharge, and complications
  - 2) Increased BMI and inadequate intraoperative renal perfusion are **modifiable** risk factors associated with postoperative AKI

# Methods: Overview

- **Study design:** Retrospective Case Control
- **Data source and collection:** Rothman Orthopedic Institute Database
- **Population/study sample:** Patients undergoing THA or TKA between 2005 and 2017 with minimum 2-year f/u
- **Intervention:** THA or TKA
- **Comparison group:** Patients who developed AKI vs. Patients who did not post-op
- **Outcome:** 1) Risk factors for the development of AKI and 2) AKI effect on post-operative pt. outcomes vs. controls





# Methods: Data Collection

- **Data Collection**
  - Demographics
  - Operative Variables
    - Surgical time, antibiotic prophylaxis, EBL, Hgb
  - Medical comorbidities
    - CHF, dementia, CKD, DM, etc.
  - Outcomes Measures
    - Complications, LOS, discharge to facility, readmission, 90-day mortality
  - Creatinine level measurement (pre/post)
    - AKI defined as increased in serum creatinine by 50% or 0.3mg/dl on postop day 1 from preop measurements



## Statistical analyses

- performed to identify significant risk factors in patients who developed AKI and its effect on post-operative outcomes as compared to control
  - Continuous variables → Mann-Whitney test
  - Categorical variables → Chi-square analysis
  - Independent effect of AKI on secondary outcomes → Multivariate regression

# Results: Risk Factors

## Demographics

- 20,800 patients who underwent unilateral primary THA (n=10,601) or TKA (n=10,199) from 2005 to 2017
- 814 (3.9%) patients developed AKI vs. 19, 986 patients did not develop AKI

## Patient Risk Factors

- Patients who developed AKI had significantly higher:
  - Age (66.4 vs 63.4,  $p<0.001$ )
  - BMI (31.8 vs 30.0,  $p<0.001$ )
  - Rates of 10 of the 17 assessed comorbidities (Appendix 1)

## Operative Risk Factors

- Patients who developed AKI had:
  - Significantly lower Preoperative Hgb levels (13.1 vs. 13.5,  $p<0.001$ ).
  - more likely to undergo TKA (55% vs 49%,  $p=0.002$ )
  - Significantly longer operative times (90 vs. 79 min,  $p<0.001$ ),
  - less likely to receive TXA (14% vs. 22%,  $p<0.001$ ),
  - Received greater intraoperative RBC transfusion units (2.1 vs 0.4,  $p=0.015$ )

# Results: Outcomes

## Clinical Outcomes

- Patients developing AKI had significantly higher:
  - rates of all in-hospital complication types except for gastrointestinal complications
  - greater LOS (3.6 vs 2.8 days,  $p < 0.001$ )
  - discharge to facility rates (37% vs 23%,  $p < 0.001$ )
  - 90-day mortality rates (1% vs. 0.1%,  $p < 0.001$ )
  - 1-year PJI rates (1.8% vs. 0.7%,  $p = 0.001$ )

## Multivariate Analysis

- AKI significantly increased
  - LOS by 0.26 days (95% CI 0.14-0.38,  $p < 0.001$ ).
  - Risk of in-hospital complications (OR=1.73, 95% CI 1.45-2.07,  $p < 0.001$ )
  - Risk of being discharged to a facility (OR=1.26, 95% CI 1.05-1.53,  $p = 0.012$ )



# Conclusions

- AKI has significant adverse effects on short-term outcomes metrics including length of stay, discharge to a facility, and increased rate of in-hospital complications
- While most risk factors for developing AKI may not be modifiable, efforts to reduce BMI preoperatively and maintaining adequate renal perfusion (anemia, estimated blood loss, and length of surgery) intraoperatively may aid in mitigating this risk.



# Future Directions

- Future studies should be performed to determine if employing strategies to address modifiable risk factors pre- and intra-operatively reduce the incidence of AKI in patients undergoing TJA
- Treatment of anemia prior to TJA may be beneficial to prevent AKI
- Efforts to limit blood loss, such as using TXA, which demonstrated a protective effect in our analysis, may be effective in reducing risk of AKI



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# Appendix.

## Appendix 1. Patient Demographics and Comorbidities by groups of 'AKI'

	No N=19986	Yes N=814	p-value
<b>Patient Age</b>	63.4 (11.3)	66.4 (11.1)	<0.001
<b>Body Mass Index</b>	30.0 (5.73)	31.8 (6.20)	<0.001
<b>Sex</b>			<0.001
Female	11171 (55.9%)	367 (45.1%)	
Male	8815 (44.1%)	447 (54.9%)	
<b>Medical Comorbidities</b>			
Anemia	6777 (34.1%)	433 (53.4%)	<0.001
AIDS	17 (0.09%)	3 (0.37%)	0.041
Congestive Heart Failure	336 (1.68%)	50 (6.14%)	<0.001
Chronic Pulmonary Disease	2392 (12.0%)	125 (15.4%)	0.004
Cerebrovascular Disease	230 (1.15%)	20 (2.46%)	0.001
Dementia	27 (0.14%)	5 (0.61%)	0.008
Diabetes Mellitus	252 (1.26%)	22 (2.70%)	0.001
Hemiparesis	6 (0.03%)	1 (0.12%)	0.244
Malignancy	218 (1.09%)	14 (1.72%)	0.132
Metastatic Disease	45 (0.23%)	3 (0.37%)	0.437
Myocardial Infarction	844 (4.22%)	67 (8.23%)	<0.001
Mild Liver Disease	90 (0.45%)	6 (0.74%)	0.280
Moderate-Severe Liver Disease	12 (0.06%)	2 (0.25%)	0.102
Peptic Ulcer Disease	73 (0.37%)	5 (0.61%)	0.234
Peripheral Vascular Disease	261 (1.31%)	24 (2.95%)	<0.001
Chronic Kidney Disease	315 (1.58%)	74 (9.09%)	<0.001
Connective Tissue Disease	650 (3.25%)	32 (3.93%)	0.334
Charlson Comorbidity Index	0.40 (0.88)	0.84 (1.43)	<0.001



# Appendix.

Appendix 1  
(continued).  
Patient  
Demographics  
and  
Comorbidities  
by groups of  
'AKI'

	No <i>N=19986</i>	Yes <i>N=814</i>	p-value
<b>Tobacco Use</b>			<0.001
Current	1830 (9.16%)	52 (6.39%)	0.007
Former	6821 (34.1%)	333 (40.9%)	<0.001
None	11334 (56.7%)	429 (52.7%)	0.024
<b>Illicit Drug Use</b>			0.203
No	19557 (97.9%)	798 (98.0%)	
Former	250 (1.25%)	13 (1.60%)	
Yes	178 (0.89%)	3 (0.37%)	
<b>Preoperative Creatinine (mg/dL)</b>	0.90 (0.30)	1.11 (1.11)	<0.001
<b>Preoperative BUN (mg/dL)</b>	17.7 (6.30)	20.2 (8.05)	<0.001
<b>Preoperative Hemoglobin (g/dL)</b>	13.5 (1.41)	13.1 (1.62)	<0.001





# Appendix.

## Appendix 2. Outcomes by groups of 'AKI'

	No <i>N=19986</i>	Yes <i>N=814</i>	p-value
<b>Postoperative Creatinine</b>	0.87 (0.27)	1.59 (1.28)	0.000
<b>Postoperative BUN</b>	13.2 (5.62)	23.3 (9.32)	<0.001
<b>Postoperative Hemoglobin</b>	10.4 (1.43)	9.82 (1.49)	<0.001
<b>Complication</b>	3416 (17.1%)	267 (33.0%)	<0.001
Cardiovascular Complications	656 (3.28%)	45 (5.53%)	0.001
DVT/PE	152 (0.76%)	15 (1.84%)	0.001
Pulmonary Complications	148 (0.74%)	18 (2.21%)	<0.001
GI Complications	1153 (5.77%)	41 (5.04%)	0.422
GU Complications	300 (1.50%)	90 (11.1%)	<0.001
Neurological Complications	182 (0.91%)	17 (2.09%)	0.001
Infectious Complications	210 (1.05%)	17 (2.09%)	0.009
<b>Discharge to Facility</b>	4666 (23.4%)	301 (37.4%)	<0.001
<b>Length of Stay</b>	2.76 (2.37)	3.59 (2.59)	<0.001
<b>Readmission</b>	793 (3.97%)	42 (5.16%)	0.108
<b>90-day Mortality</b>	28 (0.14%)	8 (0.98%)	<0.001
<b>1-year PJI</b>	143 (0.72%)	15 (1.84%)	0.001



# Appendix.

## Appendix 3. Relative Variable Importance

