

Redefining Renal Risk: Identifying Data-Driven eGFR Thresholds that Predict 90-day Major Complications following Total Knee Arthroplasty in Patients with Chronic Kidney Disease

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INTRODUCTION: Patients with chronic kidney disease (CKD) have increased risk of complications following primary total knee arthroplasty (TKA). Conventional CKD staging based on estimated glomerular filtration rate (eGFR) has been applied for preoperative TKA planning, yet this staging system was not created specifically to guide risk stratification for TKA. Therefore, the purpose of this study was to determine eGFR thresholds for CKD patients that are associated with varying risks of 90-day major complications following TKA.

METHODS: Patients who underwent primary TKA were identified using a national database. Only non-dialysis patients with CKD and known eGFR levels one-month before TKA were included in this analysis. Stratum-specific likelihood ratio (SSLR) analysis was used to construct data-driven eGFR thresholds associated with varying risk of 90-day major complications (death, sepsis, acute kidney injury, myocardial infarction, stroke, and pulmonary embolism). The incidence rates for 90-day major complications were recorded for each strata. To control for confounding variables, each strata were propensity-score matched to the highest eGFR strata based on age, sex, diabetes mellitus, hypertension, heart failure, chronic obstructive pulmonary disease, and obesity. The risk ratio (RR) for 90-day major complications were recorded for each strata.

RESULTS: A total of 24,895 patients with CKD who underwent TKA were identified. SSLR identified four data-driven eGFR strata (ml/min): 15-31, 32-44, 45-54, and 55+. The unmatched 90-day major complication incidence increased sequentially as the eGFR strata decreased (ml/min): 55+ (10.72%), 45-54 (13.87%), 32-44 (17.30%), and 15-31 (25.16%). When compared to the matched highest eGFR strata (55+), the risk of sustaining a 90-day major complication increased sequentially as the eGFR strata decreased: 44-54 (RR: 1.26; p<0.001), 32-44 (RR: 1.56; p<0.001), 45-54 (RR: 2.06; p<0.001). The risk of death within 90-days was higher in the 15-31 strata (RR: 3.08, p < 0.001) when compared to the matched 55+ strata.

DISCUSSION AND CONCLUSION: Using SSLR analysis, four data-driven strata associated with varying risks of 90-day major complications following TKA were identified. As these eGFR thresholds were created specifically for TKA, they can be utilized to risk-stratify CKD patients in the preoperative setting when discussing TKA.

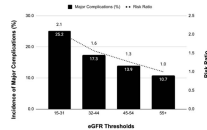


Figure 1: Incidence of major complications following total knee arthroplasty identified by data-driven eGFR thresholds. Stratum-specific likelihood ratio (SSLR) analysis was used to construct data-driven eGFR thresholds associated with varying risk of 90-day major complications (death, sepsis, acute kidney injury, myocardial infarction, stroke, and pulmonary embolism). The risk of sustaining a 90-day major complication increased sequentially as the eGFR strata decreased.

Table 1: Stratum-Specific Likelihood Ratio Analysis for 90-Day Major Complications

eGFR Threshold (ml/min)	SSLR	95% CI	p-value
15-31	2.06	1.56 - 2.74	<0.001
32-44	1.56	1.18 - 2.06	<0.001
45-54	1.26	0.98 - 1.61	<0.001
55+	1.00	-	-

Table 2: Demographic and Comorbidity Characteristics

Characteristic	Total	15-31	32-44	45-54	55+
Total	24,895	2,000	2,000	2,000	2,000
Age (Mean)	68.5	68.5	68.5	68.5	68.5
Sex (Male %)	50.0	50.0	50.0	50.0	50.0
Diabetes Mellitus (%)	25.0	25.0	25.0	25.0	25.0
Hypertension (%)	45.0	45.0	45.0	45.0	45.0
Heart Failure (%)	15.0	15.0	15.0	15.0	15.0
Chronic Obstructive Pulmonary Disease (%)	10.0	10.0	10.0	10.0	10.0
Obesity (%)	30.0	30.0	30.0	30.0	30.0

Table 3: Unmatched Major Complications by eGFR Threshold

Complication	15-31	32-44	45-54	55+
Death	10.72%	13.87%	17.30%	25.16%
Sepsis	1.5%	2.0%	2.5%	3.0%
Acute Kidney Injury	2.0%	2.5%	3.0%	3.5%
Myocardial Infarction	1.0%	1.5%	2.0%	2.5%
Stroke	1.0%	1.5%	2.0%	2.5%
Pulmonary Embolism	1.0%	1.5%	2.0%	2.5%

Table 4: Matched Major Complications by eGFR Threshold

Complication	15-31	32-44	45-54	55+
Death	3.08	1.56	1.26	1.00
Sepsis	1.56	1.26	1.00	1.00
Acute Kidney Injury	2.06	1.56	1.00	1.00
Myocardial Infarction	1.56	1.26	1.00	1.00
Stroke	1.56	1.26	1.00	1.00
Pulmonary Embolism	1.56	1.26	1.00	1.00