

Title: A risk calculator incorporating preoperative opioid use to predict early revision of total-knee arthroplasty

Background: Over 600,000 total-knee arthroplasties (TKAs) are performed in the United States each year, with 6% requiring revision after 5 years due to wear, osteolysis, instability, infection, or other causes. Some risk factors for TKA revision have previously been elucidated. However, given the expense and increased morbidity associated with TKA revision, we sought to create a freely available online risk calculator to predict early TKA revision. Additionally, due to the high and growing prevalence of preoperative opioid use, we specifically aimed to investigate the role of opioids in TKA revision.

Methods: We retrospectively analyzed the medical records from all Veterans Administration patients who underwent unilateral TKA from 2006-2011. Cases with missing or illogical data, like revision dated before initial TKA, were excluded. Preoperative daily morphine equivalent dosages were calculated for each patient based on prescription records. Univariate analysis of TKA revision by opiate use, stratified into thirds, was performed using Kaplan-Meier curves. A multivariate model to predict TKA revision was then generated using stepwise Cox proportional hazard models. For these models, daily morphine equivalent dose was included as a continuous variable. P-values less than 0.05 were considered significant. Our final model was used to create the risk calculator.

Results: Initially 34,461 patients were identified, with 33,642 remaining after exclusion. Follow-up time ranged from 1 to 7 years (median = 3.81). There were 1,715 revisions (5.10%). Figure 1 displays a Kaplan-Meier curve comparing TKA revision by opiate use group. Patients not using opiates were less likely to need a revision than patients using up to 3.7 morphine equivalents daily ($p = 0.016$). Furthermore, patients using up to 3.7 morphine equivalents daily were less likely to be revised than patients using more ($p = 0.002$). For the final Cox model, hazard ratios and associated p-values for all variables included are listed in Table 1. Daily morphine equivalents were independently associated with TKA revision (HR 1.0007, $p = 0.00358$). Using the final model, we generated a risk calculator for TKA revision. A screenshot of the application is shown in Figure 2.

Conclusions: Opioid use is associated with TKA revision in a dose-dependent manner. While the hazard ratio approaches 1, this is for each morphine equivalent. For example, the hazard ratio for a patient using 30 morphine equivalents would be 1.0007^{30} . This association could prove useful for preoperative evaluation and optimization. To aid in patient and provider decision making regarding TKA, a risk calculator for TKA revision using our final model is available at bit.do/tka.

Figure 1: Kaplan-Meier curve of TKA revision rates stratified by opiate use.

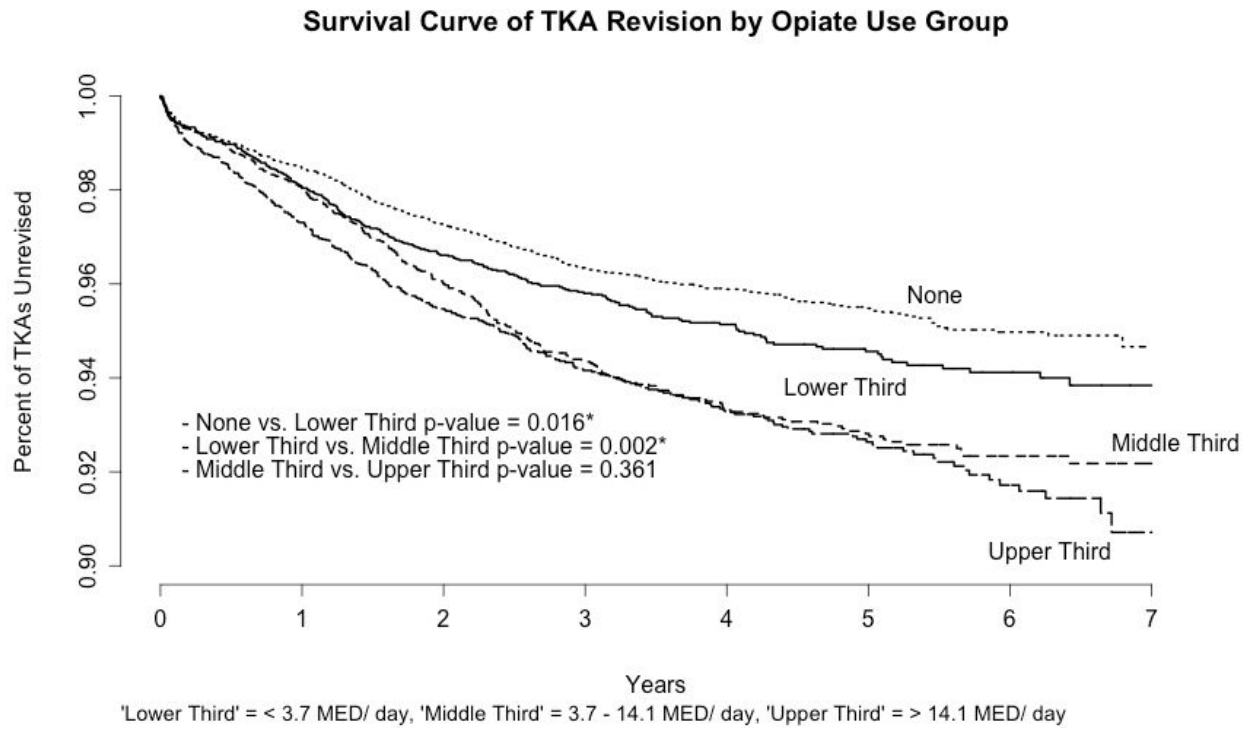


Table 1: Results of the final Cox proportional hazard model.

Variable	Hazard Ratio	95% CI	P-Value
Age	0.9510	0.9454 - 0.9565	$< 2 \times 10^{-16} *$
BMI	0.9892	0.9800 - 0.9984	0.02163 *
CKD	1.5173	1.2744 - 1.8064	$2.8 \times 10^{-06} *$
Diabetes	1.2021	1.0721 - 1.3477	0.00161 *
Morphine Equivalent Dose (Daily)	1.0007	1.0002 - 1.0012	0.00358 *

Figure 2: Screenshot of TKA revision probability calculator at bit.do/tka.

