

# Performance of Machine Learning versus Traditional Regression Models in Predicting Uncontrolled Perioperative Pain in Patients Undergoing Primary Total Knee Arthroplasty

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## INTRODUCTION:

Severe, early postoperative pain following total knee arthroplasty (TKA) delays recovery and hospital discharge. This study aims to determine the prevalence of uncontrolled postoperative pain after primary TKA and to identify factors associated with uncontrolled pain using both machine learning (ML) and traditional regression models.

## METHODS:

A retrospective review of 11,950 consecutive opioid-naïve patients between 2016-2020 who underwent unilateral TKA for primary osteoarthritis were queried. Uncontrolled pain was defined as having a visual analog scale >4 at two timepoints within the first 4 postoperative hours, at least 1 hour apart. For the ML analysis, all patients were randomly stratified into training (n=9,560) and independent hold-out sets for validation (n=2,390). Thirty routinely collected factors were investigated for association with uncontrolled pain using a random forest recursive feature elimination algorithm and to guide model training. The same potential 30 covariates were used for logistic regression models with standard stage-wise selection techniques.

## RESULTS:

A total of 1,820 patients (15.2%) experienced uncontrolled pain. The ML algorithm (c-statistic 0.65) identified five variables that optimized the accuracy of uncontrolled pain prediction: use of general anesthesia, BMI >30.4, age >67 years, and no intraoperative TXA use or IPACK block. Regression analyses (c-statistic 0.65) found use of general anesthesia (OR 2.917), BMI > 30.4 (OR 1.363), history of anxiety or depression (OR 1.144), active smoker (OR 1.356), IPACK block (OR 1.901), and intraoperative IV acetaminophen use (OR 1.267) to be predictive of uncontrolled pain (Table 1).

## DISCUSSION AND CONCLUSION:

Both statistical approaches indicate use of general anesthesia and a BMI of >30.4 increase the risk for developing uncontrolled postoperative pain. Despite substantial factors provided for modeling, neither approach demonstrated satisfactory predictive power. This suggests uncontrolled pain is a multifactorial event and other risk factors need to be explored to improve predictive power and accurately identify preventable risk factors.

**Table 1.** Pre- and perioperative covariates predictive of early, uncontrolled postoperative pain using traditional regression models.

Pre- and Perioperative Covariate	Odds Ratio	95% Wald Confidence Limits	
Age >67 years	0.701	0.631	0.778
BMI >30.4	1.363	1.229	1.512
History of Anxiety or Depression	1.144	1.009	1.298
Smoker	1.356	1.076	1.709
Anesthesia General (vs Regional)	2.917	2.219	3.835
IPACK Block	1.901	1.692	2.135
IV TXA use	0.716	0.622	0.823
Cemented Fixation (vs Cementless)	0.763	0.600	0.972
Intraoperative IV Toradol	0.773	0.694	0.860
Intraoperative IV Tylenol	1.267	1.128	1.423
Intraoperative IV Dexamethasone	0.876	0.782	0.982