Machine Learning Approach to Predict Acute Kidney Injury Among Patients Undergoing Spinal Posterior Instrumented Fusion

Kevin Heo, BS; Prashant V. Rajan, MD; Sameer Khawaja, BS; Lauren A. Barber, MD; Sangwook T. Yoon, MD, PhD

Emory University Department of Orthopaedics

INTRODUCTION

- Acute kidney injury (AKI) after spine surgery can lead to significant morbidity and poor outcomes
- Few studies have evaluated perioperative risk factors associated with AKI after spine surgery
- Study Aims:
  - Incorporate machine learning (ML) models to stratify risk factors for 90-day AKI from a large, national database
  - Develop a simple predictive risk calculator for postop AKI

METHODS

IBM MarketScan database queried for patients who underwent spinal posterior instrumented fusion **2009-2021**

Excluded traumas, malignancies, or infections

90-day AKI collected w/ ICD codes

Demographics and patient comorbidities collected

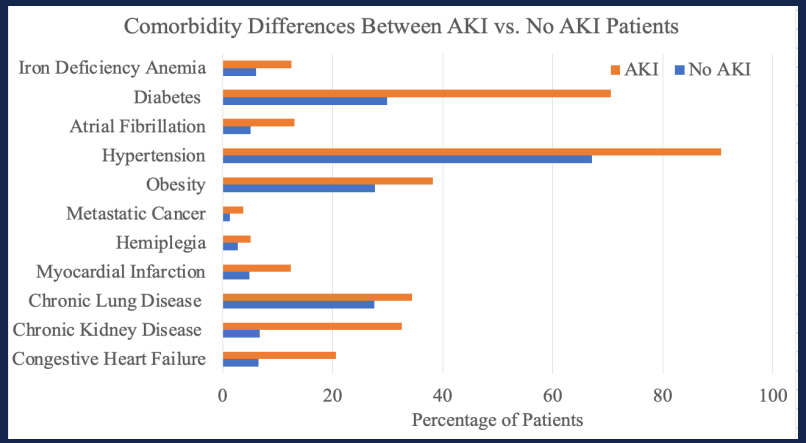
5 ML models w/ k-fold cross validation using 80-20% split

XGBoost Tree | Logistic Regression | Random Forest | Neural Networks | Linear Support Vector Machine

RESULTS

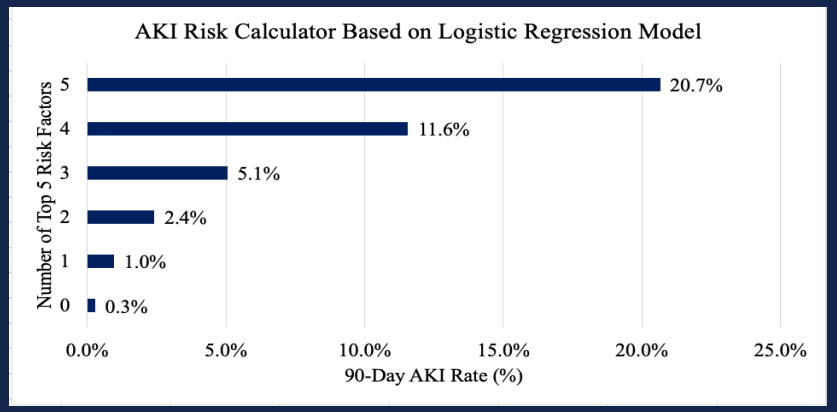
Table 1. Baseline Demographic Data by 90-Day Acute Kidney Injury (AKI) Cohort

	No AKI*	AKI	*P*-value
Total Patients (n, %)	137,505 (97.04%)	4,192 (2.96%)	
Age (avg, SD*)	58.24 (11.87)	64.80 (10.36)	<0.001
Female Patients (n, %)	73,778 (53.65%)	1,735 (41.39%)	<0.001
CCI* Score (avg, SD)	1.81 (2.22)	3.89 (3.27)	<0.001



Model	AUROC	Variable 1	Variable 2	Variable 3	Variable 4	Variable 5
Logistic Regression	0.75	Chronic Renal Disease	Hypertension	Diabetes w/o Complications	Older Age	Congestive Heart Failure

- **Logistic regression** performed the best w/ AUC of 0.75
- Top 5 risk factors for AKI listed above according to logistic regression model
  - CKD, HTN, Diabetes, Older Age (>65 y/o), CHF



DISCUSSION

- Logistic regression had the best prediction rates of AKI
- Top 5 risk factors: chronic kidney disease, HTN, diabetes, older age (>65), CHF
- Patients with increasing # of risk factors had increased AKI rates
- Patients with high risk factors may require optimal medical management and closer follow up after surgery
- ML models can be utilized to build user interfaces for patients/physicians
- Advantages: >140,000 patients incorporated, large input of risk factors
- Limitations: lab values, operative notes unavailable, med adherence unknown

REFERENCES

- Ilyas H, Golubovsky JL, Chen J, Winkelman RD, Mroz TE, Steinmetz MP. Risk factors for 90-day reoperation and readmission after lumbar surgery for lumbar spinal stenosis. *J Neurosurg Spine*. 2019;31(1):20-26. doi:10.3171/2019.1.SPINE18878
- Naik BI, Colquhoun DA, McKinney WE, et al. Incidence and risk factors for acute kidney injury after spine surgery using the RIFLE classification. *J Neurosurg Spine*. 2014;20(5):505-511. doi:10.3171/2014.2.SPINE13596
- Shohat, N., Goswami, K., Tan, T. L., Yayac, M., Soriano, A., Sousa, R., Wouthuyzen-Bakker, M., Parvizi, J., & ESCMID Study Group of Implant Associated Infections (ESGIAI) and the Northern Infection Network of Joint Arthroplasty (NINJA) (2020). 2020 Frank Stinchfield Award: Identifying who will fail following irrigation and debridement for prosthetic joint infection. *The bone & joint journal*, *102-B*(7_Supple_B), 11–19. https://doi.org/10.1302/0301-620X.102B7.BJJ-2019-1628.R1