



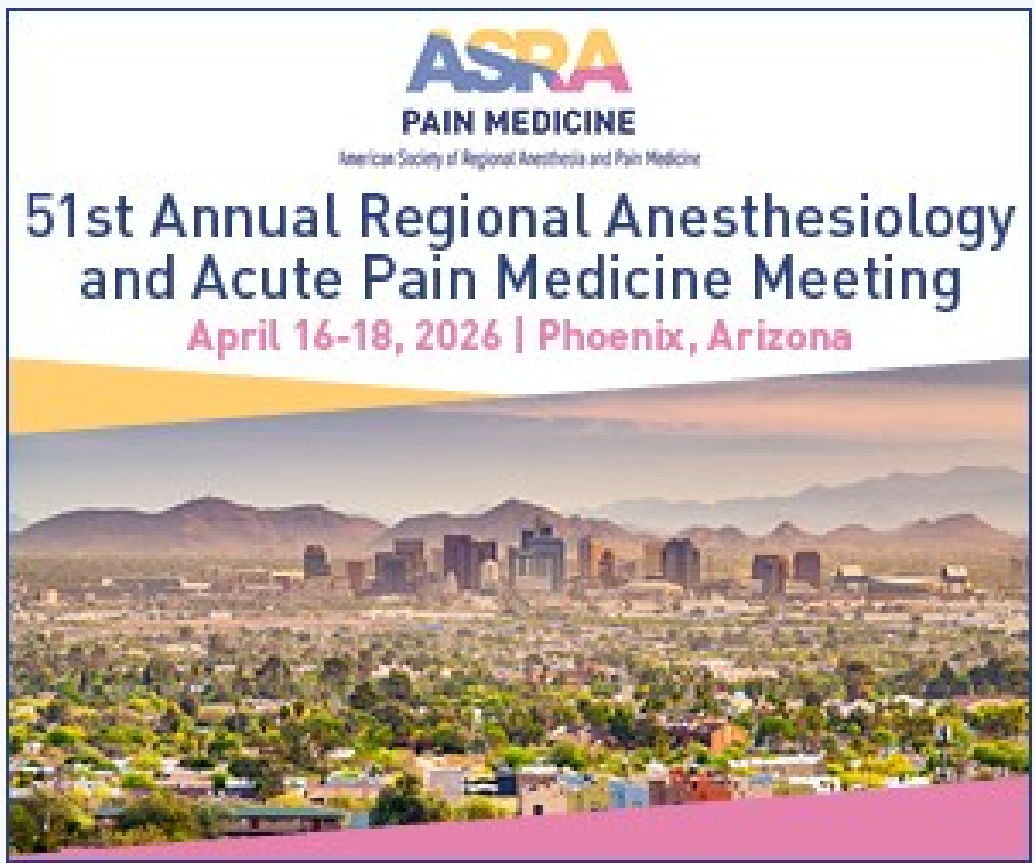
Predicting Persistent Postoperative Pain After Total Knee Arthroplasty Using Machine Learning with Clinical and Biological Data

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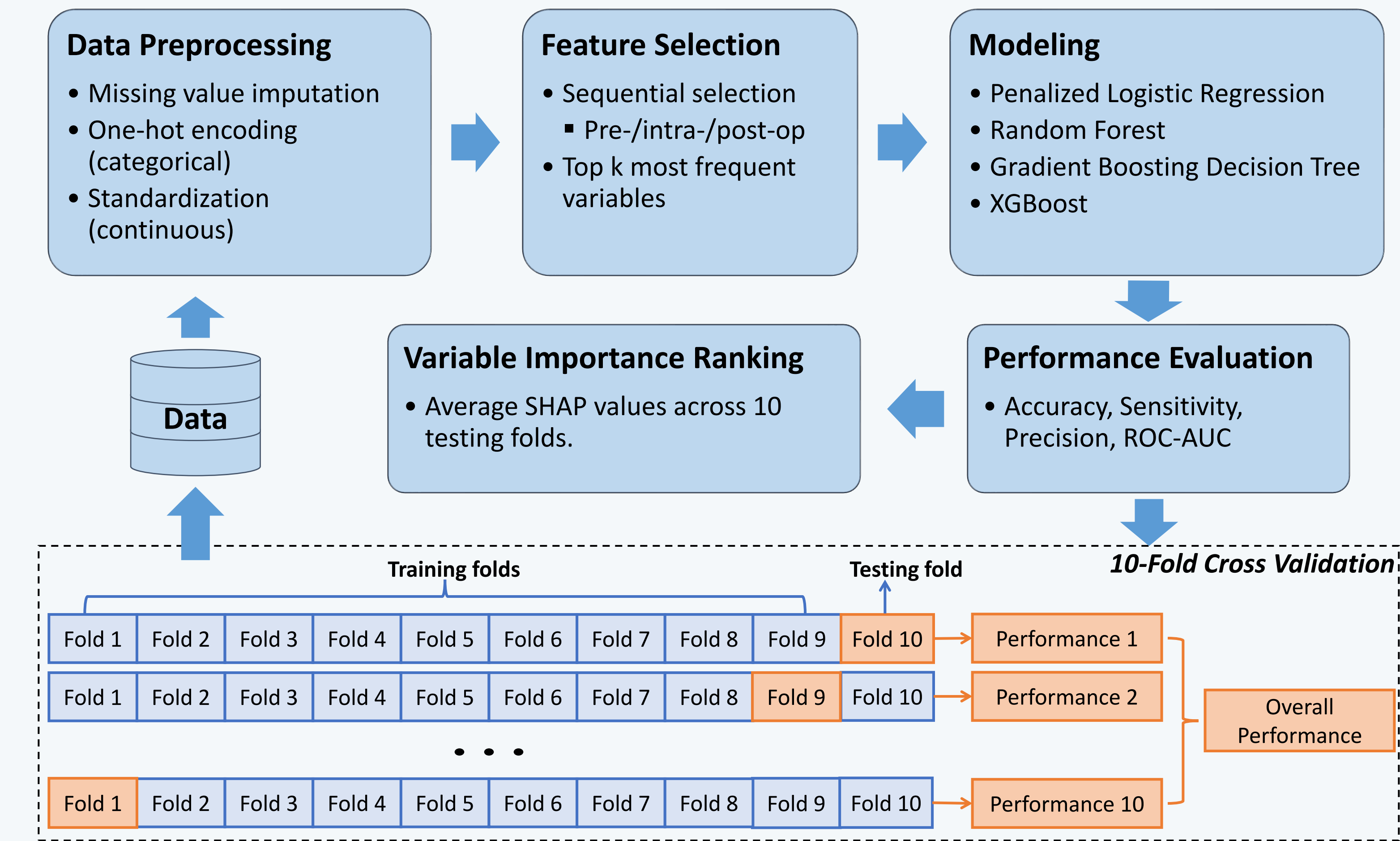


INTRODUCTION

- Persistent postoperative pain (PPP) affects ~20% of patients after Total Knee Arthroplasty (TKA).
- PPP patients show distinct perioperative clinical profiles that may influence long-term outcomes.
- Contributions of clinical & biological factors (e.g., cytokines) to PPP risk remain poorly understood.
- **Goal:** Apply a machine learning (ML) approach to identify key clinical and biological predictors of PPP after TKA.

METHODS

- IRB #2016-361: 160 patients with 318 clinical and biological (serum cytokine/adipokine levels) features (2016/5-2018/2).
- PPP definition: NRS>0 at 6 months post-TKA.

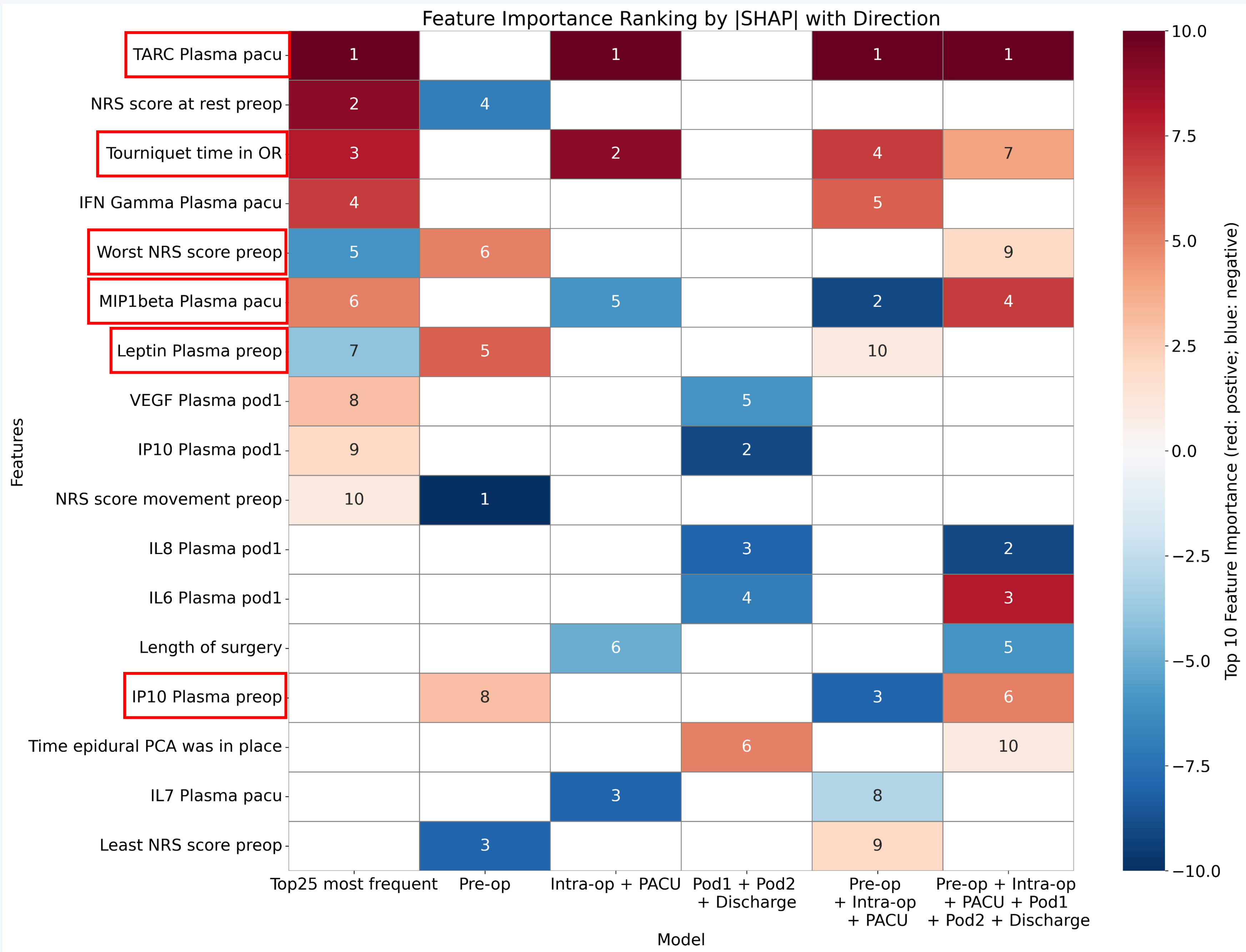


Main findings & tables/figures

Table: Model performance results for predictive modeling

Variables	Model	Accuracy	Sensitivity	Precision	ROC-AUC
Pre-op (n=20)	Penalized Logistic	0.61	0.62	0.59	0.64
Intra-op + PACU (n=17)	XGBoost	0.62	0.60	0.65	0.70
Pod1 + Pod2 + Discharge (n=22)	XGBoost	0.60	0.56	0.61	0.62
Pre-op + Intra-op + PACU (n=37)	Gradient Boosting	0.66	0.65	0.64	0.71
Pre-op + Intra-op + PACU + Pod1 + Pod2 + Discharge (n=59)	XGBoost	0.64	0.66	0.61	0.72
Top 25 most frequent features (n=25)	XGBoost	0.69	0.67	0.69	0.78

Figure: Common top 10 most important features from ML models using 6 different feature selection methods (Red – Positive association with PPP; Blue – Negative)



RESULTS

- PPP: n=79 (49.4%) vs Non-PPP: n=81 (50.6%).
- Top features associated with higher risk of PPP included:
 - higher plasma thymus- and activation-regulated chemokine (TARC) levels in the PACU
 - higher preoperative NRS pain score at rest
 - longer tourniquet time in the OR
 - higher plasma IFN Gamma in PACU
 - lower worst preoperative NRS score
- Most consistently important features across models are highlighted in red boxes in the Figure.

DISCUSSION

- We successfully identified key early clinical and biological predictors of PPP six months after TKA using ML, achieving acceptable discrimination ability.
- TARC levels in PACU consistently emerged as the most important feature across multiple models, alongside OR tourniquet time and PACU MIP1beta levels.
- These findings highlight the importance of incorporating cytokine analysis and patient-specific pain profiles in predicting PPP, suggesting that integrating high dimensional clinical and biological data can improve early identification of high-risk patients.
- Future works may focus on comparing findings using NRS≥3 as PPP definition.