

**PRIMARCH-APP AI: Development and Internal Validation of an Explainable Machine Learning Model for Preoperative Prediction of Complicated Acute Appendicitis**

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**Abstract**

*Background:* Early identification of complicated acute appendicitis may improve preoperative risk stratification and support surgical decision-making. This study aimed to develop and internally validate an explainable machine-learning model for predicting complicated acute appendicitis using routinely available preoperative variables.

*Methods:* In this prospective observational cohort study, 199 adult patients undergoing emergency appendectomy were included. Demographic, clinical, laboratory, scoring, and imaging variables collected before surgery were used to develop logistic regression, random forest, and XGBoost models. Performance was evaluated using five-fold cross-validation and a stratified held-out test set. Model explainability was assessed using SHapley Additive exPlanations (SHAP).

*Results:* Complicated acute appendicitis was identified in 57/199 patients (28.6%). Random forest and XGBoost achieved the highest test ROC-AUC (0.934). Random forest demonstrated the best overall probability performance, with 87.5% accuracy, 72.7% sensitivity, 93.1% specificity, and a Brier score of 0.091. SHAP analysis identified heart rate, Alvarado score, rebound tenderness, symptom duration, and appendiceal diameter among the most influential predictors.

*Conclusions:* PRIMARCH-APP AI demonstrated high discrimination and clinically interpretable prediction of complicated acute appendicitis using routinely available preoperative data. External and prospective multicenter validation is required before clinical implementation.

**Keywords:** acute appendicitis, complicated appendicitis, machine learning, artificial intelligence, explainable artificial intelligence, SHAP, risk prediction