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COLOSSUS-AI: A Pilot Study on Artificial Intelligence–Driven Prediction of Postoperative Outcomes in Colorectal Surgery

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Abstract
Background: Postoperative complications remain a major source of morbidity after colorectal surgery and are associated with prolonged hospitalization, reintervention, intensive care unit admission, and increased mortality. Early identification of high-risk patients remains challenging due to the heterogeneity of colorectal surgical populations. Artificial intelligence and machine learning methods may support individualized risk prediction by integrating clinical, biological, and operative variables.
Aim: This study aimed to develop and internally evaluate a preliminary machine learning model, named
COLOSSUS-AI, for predicting early postoperative adverse outcomes after colorectal surgery.
Material and Methods: This retrospective, single-center, observational pilot study included 310 patients undergoing colorectal surgery. Demographic, clinical, laboratory, disease-specific, operative, and postoperative data were retrospectively collected and organized into a structured database comprising 84 variables. The primary endpoint was postoperative adverse outcome. Three predictive models were evaluated: logistic regression, random forest, and gradient boosting. Model performance was assessed using receiver operating characteristic curve analysis, area under the curve, accuracy,
sensitivity, and specificity.
Results: Postoperative adverse outcomes occurred in 120 patients (38.7%). Adverse outcomes were associated with older age, urgent or emergency admission, increased inflammatory markers, higher neutrophil-to-lymphocyte ratio, lower preoperative albumin, impaired renal function parameters, anastomotic leak, and in-hospital mortality. Among the evaluated models, gradient boosting achieved the best predictive performance, with an area under the receiver operating characteristic curve of 0.886, accuracy of 81.7%, sensitivity of 72.2%, and specificity of 87.7%. Random forest achieved an area under the curve of 0.841, while logistic regression achieved an area under the curve of 0.768.
Conclusions: The COLOSSUS-AI pilot study suggests that routinely collected perioperative data can be used to develop exploratory machine learning models for predicting postoperative adverse outcomes after colorectal surgery. Although gradient boosting showed the best preliminary performance, these findings should be interpreted cautiously. External validation in larger multicenter cohorts is required before clinical implementation.
Keywords: colorectal surgery, artificial intelligence, machine learning, postoperative complications, predictive model, anastomotic leak, gradient boosting.