ARTIFICIAL INTELLIGENCE FOR PREDICTING POSTOPERATIVE COMPLICATIONS IN GENERAL SURGERY

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Background. Postoperative complications remain a major cause of prolonged hospitalization, increased postoperative morbidity, healthcare costs, and mortality. Traditional surgical risk assessment systems, including the American Society of Anesthesiologists (ASA) classification, POSSUM, P-POSSUM, and ACS NSQIP, are widely used in clinical practice; however, their ability to account for complex interactions among multiple perioperative factors is limited. Advances in artificial intelligence (AI), machine learning, and deep learning have enabled the simultaneous analysis of demographic, laboratory, physiological, intraoperative, and electronic health record data, thereby facilitating individualized risk assessment for postoperative complications.

Objective. To evaluate the effectiveness and clinical potential of artificial intelligence methods for predicting postoperative complications in general surgery, as well as to identify their advantages over traditional surgical risk assessment systems and the main limitations of their clinical application.

Materials and Methods. A systematic analysis of studies investigating the use of AI for predicting postoperative complications in adult surgical patients was performed. According to a systematic review, 1,248 publications were initially identified. After removal of duplicates, 972 studies underwent initial screening, 130 full-text articles were assessed for eligibility, and 35 studies were included in the qualitative synthesis. Machine learning and deep learning models, including Random Forest, XGBoost, artificial neural networks, Gradient Boosting, Support Vector Machine, and other algorithms, were evaluated. The outcomes assessed included overall postoperative morbidity, surgical site infection, anastomotic leakage, sepsis, acute kidney injury, respiratory failure, prolonged intensive care unit stay, readmission, and postoperative mortality.

Results and Discussion. Most AI models demonstrated high predictive performance, with AUROC values generally ranging from 0.78 to 0.95 and frequently exceeding those of traditional risk assessment systems such as ACS NSQIP, POSSUM, and P-POSSUM. The highest predictive performance was observed in models integrating laboratory parameters, physiological variables, intraoperative data, and information from electronic health records. For mortality prediction, Random Forest models demonstrated AUROC values of 0.86–0.93; for surgical site infection prediction, XGBoost achieved AUROC values of 0.88–0.95; for acute kidney injury prediction, artificial neural networks

demonstrated AUROC values of 0.80–0.90; and deep learning models for predicting clinical deterioration achieved AUROC values of 0.84–0.94.

The application of AI may facilitate the early identification of high-risk patients, individualized perioperative monitoring, optimization of healthcare resource allocation, and clinical decision support. Unlike traditional static risk calculators, contemporary AI-based systems can incorporate dynamically acquired clinical and physiological data to continuously update an individual patient's risk profile. However, widespread clinical implementation remains limited by substantial heterogeneity among studies, the predominance of retrospective single-center investigations, insufficient external validation, and differences in patient characteristics, predictors, algorithms, and outcome definitions. Additional challenges include model interpretability, algorithmic bias, transparency, ethical and regulatory considerations, and integration of AI into existing clinical workflows.

Conclusion. Artificial intelligence represents a promising tool for predicting postoperative complications in general surgery, with the potential to improve risk stratification, facilitate the timely identification of high-risk patients, and optimize perioperative management. However, widespread implementation of AI in surgical practice requires prospective multicenter studies, robust external validation, and standardized evaluation methods. At present, AI should be considered a clinical decision-support tool that complements, rather than replaces, the professional judgment of surgeons and other healthcare professionals.

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