Review Neurosurg Rev. 2025 Feb 15;48(1):240. doi: 10.1007/s10143-025-03419-y.

Application of artificial intelligence in forecasting survival in high-grade glioma: systematic review and meta-analysis involving 79,638 participants

Ibrahim Mohammadzadeh [#] [1] [2], Bardia Hajikarimloo [#] [3], Behnaz Niroomand [4], Pooya Eini [5], Ramin Ghanbarnia [4], Mohammad Amin Habibi [6], Abdulrahman Albakr [7] [8], Hamid Borghei-Razavi [9]

Affiliations

PMID: 39954167 DOI: 10.1007/s10143-025-03419-y

Abstract

High-grade glioma (HGG) is an aggressive brain tumor with poor survival rates. Predicting survival outcomes is critical for personalized treatment planning. In recent years, artificial intelligence (AI), particularly machine learning (ML) and deep learning (DL) models, has emerged as a promising approach for enhancing prognostic accuracy in HGG but this study especially focused on the potential of AI in the recurrence of HGG. A systematic review and meta-analysis were conducted to assess the performance of AI-based models in predicting survival outcomes for HGG patients. Relevant studies were retrieved from PubMed, Embase, Scopus, and Web of Science until 2 Dec 2024, using predefined keywords ("High-Grade Glioma", "Survival" and "Machine Learning") without date or language restrictions. Data extraction and quality assessment were performed in accordance with PRISMA and PROBAST guidelines. In this study were included. The pooled diagnostic metric, the area under the curve (AUC), was analyzed using random-effects models. A total of 39 studies with 29 various algorithms and 79,638 patients were included, with 15 studies contributing to the meta-analysis. The most commonly used algorithms were random forest (RF) and logistic regression (LR), which demonstrated robust predictive accuracy. The pooled AUCs for one-year, two-year, three-year and overall survival predictions were 0.816, 0.854, 0.871 and 0.789 respectively. Subgroup analysis revealed that RSF achieved the highest predictive accuracy with an AUC of 0.91 (95% CI: 0.84-0.98), while LR followed with an AUC of 0.89 (95% CI: 0.82-0.96). Models integrating clinical, radiomics, and genetic features consistently outperformed single-data-type models. MRI was the most frequently utilized imaging modality. AI-based models, particularly ML and DL algorithms, show significant potential for improving survival prediction in HGG patients. By integrating multimodal data, these models offer valuable tools for personalized treatment planning, although further validation in prospective, multicenter studies is needed to ensure clinical applicability.

Keywords: Artificial intelligence; Deep learning; High-grade glioma; Machine learning; Prognostic models; Radiomics; Survival prediction.