Adherence to TRIPOD-AI Reporting Guidelines

This study was reported in accordance with the Transparent Reporting of a multivariable prediction model for Individual Prognosis Or Diagnosis (TRIPOD) statement, extended for artificial intelligence (TRIPOD-AI). Below is a structured guide indicating where each key checklist item is addressed within the manuscript.

TITLE

- **Item 1: Identification of the model, population, and outcome.**
    - **Location:** Title.
    - **Details:** The title, "Prediction of postoperative haemorrhage after cerebral tumour surgery using machine learning algorithms," clearly specifies the study's objective (Prediction), the target outcome (postoperative haemorrhage), the population (patients undergoing cerebral tumour surgery), and the methodology (machine learning).

ABSTRACT

- **Item 2: Structured summary adhering to the TRIPOD-AI checklist.**
    - **Location:** Abstract (Page 1).
    - **Details:** The abstract provides a comprehensive summary of the study's background, methods (including patient cohort, outcome definition, use of SMOTE, calibration, and DCA), principal results (identifying LightGBM as the best model with key performance metrics), and a cautiously worded conclusion, fulfilling all essential reporting criteria.

INTRODUCTION

- **Items 3a & 3b: Healthcare context, rationale, and intended use.**
    - **Location:** Introduction, Paragraphs 1 & 2 (Page 2).
    - **Details:** The initial paragraphs establish the clinical significance of postoperative hemorrhage, the complexity of its risk factors, and the rationale for developing a predictive model. The intended use for early risk stratification in a neurosurgical setting is clearly articulated.
- **Item 4: Study objectives.**
    - **Location:** Introduction, final paragraph (Page 3).
    - **Details:** The final sentence explicitly states the study's aim: "Therefore, the aim of the current study was to develop and validate machine learning models..."

METHODS

- **Items 5 & 6: Data source, study setting, and participant criteria.**

    - **Location:** "Study design" and "Participants" sections (Page 3).
    - **Details:** The manuscript specifies the single-center, retrospective cohort design, the data collection period (January 2024–January 2025), and provides explicit inclusion and exclusion criteria for the 118 patients analyzed.
- **Item 8a: Outcome definition.**
    - **Location:** "Outcome and Predictor Variables" section (Page 3).
    - **Details:** The primary outcome (hematoma ≥5 cm^3) is precisely defined, including the method and timing of its assessment (postoperative CT at 24–48 hours) and the clinical justification for the chosen volume threshold.
- **Item 9a/9b: Predictor definition and handling.**
    - **Location:** "Outcome and Predictor Variables" section (Page 4).
    - **Details:** The manuscript reports that a predefined set of 28 preoperative predictors was used for model development. It explicitly states that postoperative variables were excluded to prevent data leakage, ensuring the model's clinical applicability for preoperative risk assessment.
- **Item 11: Missing data.**
    - **Location:** "Data Splitting and Preprocessing," "Missing Data" subsection (Page 4).
    - **Details:** It is clearly stated that the final analytical dataset contained no missing values, thereby obviating the need for imputation techniques.
- **Item 12c & 12e: Model type, validation, and performance measures.**
    - **Location:** "Machine Learning Model Development and Validation" and "Model Performance Evaluation and Interpretability" sections (Pages 4-5).
    - **Details:** The manuscript lists the full range of algorithms evaluated. It describes the robust internal validation and hyperparameter tuning strategy (5-repeated 10-fold cross-validation) and details the comprehensive suite of metrics used for final model evaluation, including discrimination (AUC), calibration (Calibration Plot), and clinical utility (DCA).
- **Item 13: Handling of class imbalance.**
    - **Location:** "Data Splitting and Preprocessing," "Handling Class Imbalance" subsection (Page 4).
    - **Details:** The application of the Synthetic Minority Over-sampling Technique (SMOTE) is described, with a crucial clarification that it was implemented correctly within the cross-validation resampling process to prevent data leakage.
- **Item 17: Ethical approval.**

- **Location:** "Study design" section (Page 3).
- **Details:** Information regarding the approving body (Kayseri City Hospital Ethics Committee), approval number, and the waiver of informed consent is provided.

RESULTS

- **Item 20b: Participant characteristics.**
  - **Location:** "Results" section and Tables 1 & 2 (Page 5).
  - **Details:** Baseline demographic, clinical, and laboratory characteristics are reported and stratified by outcome status.
- **Item 23a: Model performance.**
  - **Location:** "Comparative Model Performance" and "In-depth Analysis" sections, Table 3, and Figures 2, 3, 6, & 7 (Pages 6-7).
  - **Details:** Table 3 presents the performance of all evaluated models with 95% confidence intervals. The performance of the final LightGBM model is detailed through its confusion matrix, ROC curve, calibration plot, and DCA.

DISCUSSION

- **Item 25: Interpretation of results.**
  - **Location:** Discussion section (Pages 7-9).
  - **Details:** The main findings are interpreted in the context of their clinical implications and compared with existing literature. The significance of the key predictors is discussed.
- **Item 26: Limitations.**
  - **Location:** "Limitations of Study" section (Pages 9-10).
  - **Details:** The study's key limitations, including its single-center retrospective design, modest sample size, and the inherent "black-box" nature of the final model, are transparently discussed.
- **Item 27c: Implications for future research.**
  - **Location:** "Limitations" and "Conclusion" sections (Page 10).
  - **Details:** The manuscript strongly emphasizes that the model is a proof-of-concept and underscores that large-scale, prospective, multicenter external validation is an "essential and non-negotiable next step" before any clinical implementation can be considered.