

Nadina A., Antipina N., Vetlova E., Golanov A.

Burdenko National Medical Research Center of Neurosurgery, Moscow, Russian Federation

BACKGROUND

Radiation necrosis (RN) remains one of the most challenging complications after stereotactic radiosurgery (SRS) for brain metastases. Because RN may mimic tumor progression and significantly impair neurological function, accurate risk estimation is essential for guiding post-treatment management.

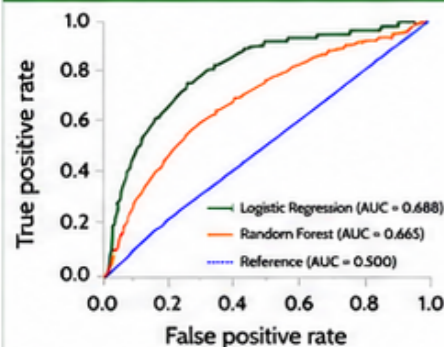
AIM

To develop machine learning-based models for predicting the risk of RN after SRS using clinical and dosimetric parameters.

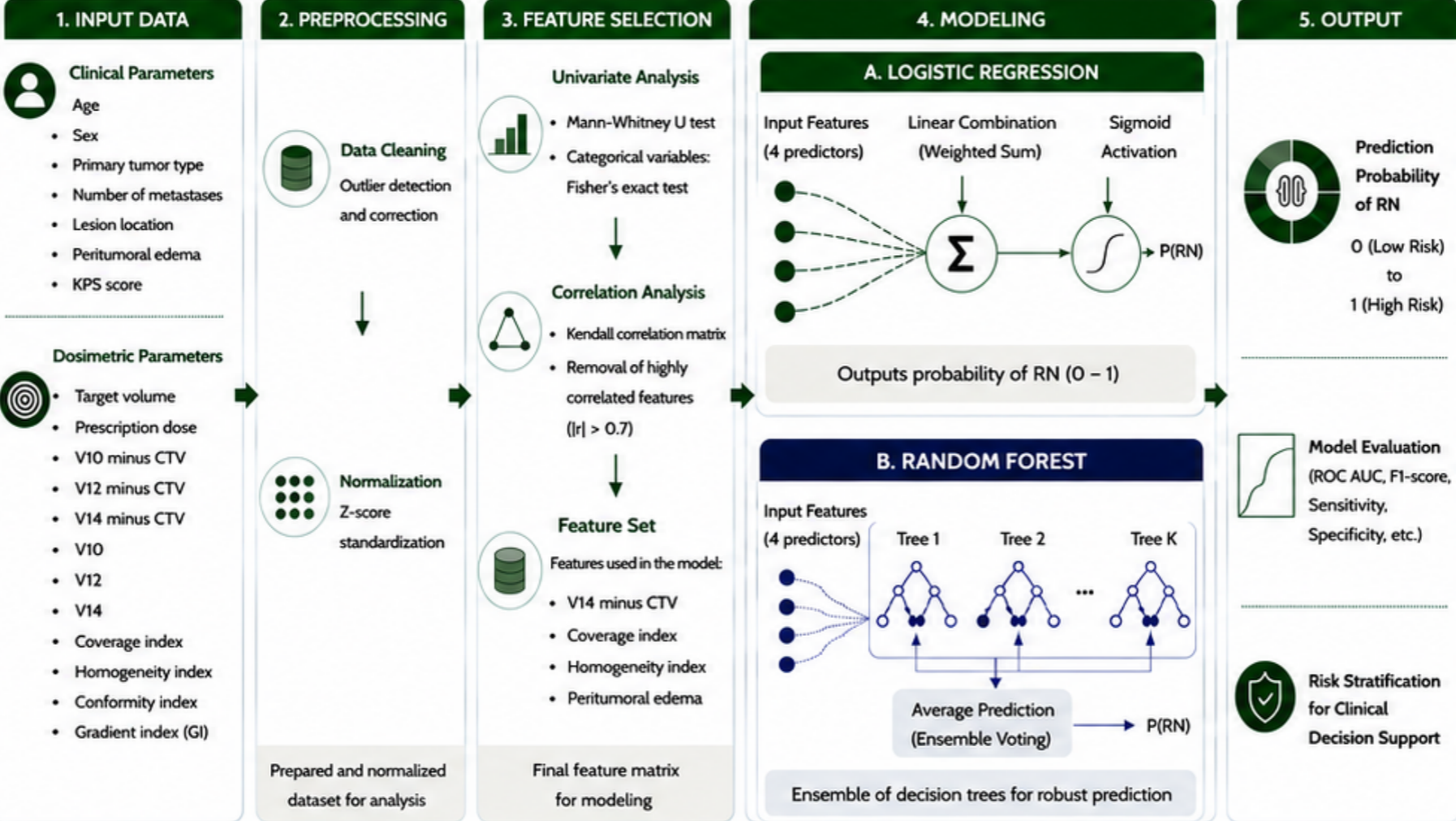
DATASET

- 96 patients
- 107 lesions
- Treatment: CyberKnife & Novalis 3x8 Gy, 5x6 Gy, 7x5 Gy converted to 1 fr ($\alpha/\beta = 3$)

RESULTS: ROC CURVES (TEST SET)



MODEL ARCHITECTURE



RESULTS: TEST SET PERFORMANCE

Metric	Logistic Regression (Primary Model)	Random Forest (Ensemble Model)
AUC	0.688	0.665
Sensitivity	88%	63%
F1-score	0.609	0.556

Logistic regression demonstrated higher sensitivity and better stability on the independent test set. The model is well-suited for identifying high-risk patients who may benefit from closer surveillance.

CONCLUSIONS

- This study developed and evaluated machine learning models for predicting radiation necrosis after SRS.
- Four routinely available parameters were incorporated into the final model.
- Logistic regression provided robust performance with high sensitivity for risk screening.
- Dosimetric metrics reflecting normal brain dose exposure contributed most to prediction accuracy.
- The proposed approach can support personalized follow-up strategies and clinical decision-making.
- Further work includes external validation, larger cohorts, and integration of radiomic imaging biomarkers.

REFERENCES

1. Inoue H.K. et al. J. Radiat. Res. 2014;55:334–342. DOI:10.1093/jrr/rrt127
2. Peng L. et al. Surg. Neurol. Int. 2019;10:32. DOI:10.4103/sni.sni_303_18
3. Minniti G. et al. Radiat. Oncol. 2011;6:48. DOI:10.1186/1748-717X-6-48

6. VALIDATION & EVALUATION FRAMEWORK

