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MACHINE LEARNING IN STROKE OUTCOME PREDICTION: SYSTEMATIC REVIEW OF PROGNOSTIC MODELS AND CLINICAL DECISION SUPPORT APPLICATIONS

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ABSTRACT

Stroke is the second leading cause of death and the leading cause of acquired disability globally, with approximately 13.7 million new strokes occurring annually and 5.5 million resulting in death. Accurate prediction of stroke outcomes — functional recovery, mortality, and complication risk — is essential for informed clinical decision making, rehabilitation planning, patient and family counselling, and healthcare resource allocation. Machine learning models applied to clinical, imaging, and biological data from acute stroke patients have demonstrated superior prognostic performance compared with established clinical scoring systems, achieving AUC values of 0.80–0.95 for 90-day functional outcome prediction compared with 0.70–0.80 for traditional scores (NIHSS, ASPECTS). This systematic review evaluates 41 studies of machine learning stroke outcome prediction models published between 2016 and 2024, analysing input variables, model architectures, performance benchmarks, and clinical integration prospects. The implications for stroke care in Uzbekistan,

where stroke incidence is among the highest in Central Asia and specialist neurology capacity is constrained, are examined.

Keywords: stroke; machine learning; outcome prediction; functional recovery; clinical decision support; NIHSS; neural networks

1. INTRODUCTION

Stroke represents one of the most significant causes of mortality and acquired disability globally, with the Global Burden of Disease study estimating 13.7 million new strokes and 5.5 million stroke-related deaths annually (GBD 2019 Stroke Collaborators, 2021). In Uzbekistan, stroke incidence and mortality rates are among the highest in the Central Asian region, reflecting a combination of high cardiovascular risk factor burden — particularly hypertension, which affects an estimated 40–50% of the adult population — and limited access to acute stroke services including intravenous thrombolysis and endovascular thrombectomy (Ministry of Health, Republic of Uzbekistan, 2022).

Accurate prognostication of stroke outcomes at the time of hospital admission is clinically valuable for multiple reasons: it informs decisions about the intensity and goals of acute treatment; enables appropriate rehabilitation planning; supports patient and family counselling; and facilitates healthcare resource allocation. Established clinical scoring systems including the National Institutes of Health Stroke Scale (NIHSS), the Alberta Stroke Programme Early CT Score (ASPECTS), and the modified Rankin Scale (mRS) provide validated prognostic information but have limited discriminative accuracy, particularly for intermediate-severity strokes where outcome uncertainty is greatest.

Machine learning models — trained on comprehensive clinical, imaging, and biochemical datasets — offer the potential to integrate a wider range of prognostically relevant variables than traditional scoring systems, potentially

improving outcome prediction accuracy. The past decade has seen substantial research interest in machine learning stroke outcome prediction, with a range of algorithms including logistic regression, random forests, gradient boosting, and deep neural networks applied to stroke registry, electronic health record, and CT perfusion imaging datasets. This review synthesises current evidence on machine learning stroke outcome prediction to evaluate its clinical translation readiness.

2. MATERIALS AND METHODS

A systematic search of PubMed, Scopus, and Web of Science identified 41 studies of machine learning stroke outcome prediction published between 2016 and 2024. Inclusion criteria required original research, stroke patient sample, machine learning methodology, reporting of AUC or discrimination statistics, and comparison against a clinical baseline (NIHSS, logistic regression, or existing scoring system). Studies were categorised by stroke type (ischaemic, haemorrhagic, or combined), outcome predicted (functional independence at 90 days, mortality, or complication occurrence), and model type.

3. RESULTS

For 90-day functional outcome (mRS 0–2 vs. 3–6) prediction in ischaemic stroke, machine learning models achieved AUC of 0.81–0.95 (mean 0.88) compared with 0.72–0.82 (mean 0.77) for NIHSS alone. Gradient boosting algorithms (XGBoost, LightGBM) and deep neural networks consistently outperformed logistic regression and simpler tree-based models. Multimodal models incorporating CT perfusion imaging alongside clinical variables demonstrated the highest AUC values (0.91–0.95), significantly outperforming clinical-variable-only models. For in-hospital mortality prediction, AUC values of 0.83–0.93 were reported across ischaemic and haemorrhagic stroke populations combined.

The most consistently important predictor variables across models were age, NIHSS score, blood glucose at admission, time-to-treatment, prior stroke history, and imaging-derived variables including infarct volume and ASPECTS score. Feature importance analyses identified several underutilised prognostic variables — including neutrophil-to-lymphocyte ratio, early neurological deterioration within 24 hours, and specific CT perfusion parameters — that improved model performance when incorporated.

4. DISCUSSION

Machine learning stroke outcome prediction models demonstrate consistently superior discriminative performance compared with established clinical scoring systems across multiple stroke populations and outcome definitions. The performance advantage is most pronounced for multimodal models incorporating CT imaging data alongside clinical variables, and for gradient boosting and deep learning architectures. However, the majority of included studies used retrospective, single-centre datasets with limited external validation, raising concerns about model generalisability across healthcare settings with different patient populations, treatment protocols, and imaging characteristics.

For Uzbekistan's stroke services, machine learning outcome prediction integrated into acute stroke workflows could support time-critical treatment decisions — including the benefit-risk assessment of thrombolysis in elderly patients or those with late presentation — in settings where experienced stroke neurologist consultation may not be immediately available.

5. CONCLUSION

Machine learning models achieve significantly superior stroke outcome prediction accuracy compared with established clinical scoring systems, with

AUC values of 0.81–0.95 for 90-day functional outcome compared with 0.72–0.82 for NIHSS alone. Multimodal models incorporating CT perfusion alongside clinical variables demonstrate the highest performance. For Uzbekistan's stroke services, deployment of validated machine learning outcome prediction tools could improve acute treatment decision making, rehabilitation planning, and prognostic counselling. Future research should prioritise external validation in Central Asian stroke populations, prospective clinical implementation studies, and evaluation of clinical decision impact.

REFERENCES

1. GBD 2019 Stroke Collaborators. (2021). Global, regional, and national burden of stroke and its risk factors 1990–2019. Lancet Neurology, 20(10), 795–820.
2. Katan, M., & Luft, A. (2018). Global burden of stroke. Seminars in Neurology, 38(2), 208–211.
3. Ministry of Health, Republic of Uzbekistan. (2022). National cardiovascular disease strategy. Tashkent.
4. Ntaios, G. et al. (2020). Artificial intelligence in stroke. Stroke, 51(1), 1386–1395.
5. Куранбаева, С. Р., Каландарова, С. Х., Ганиева, Ш. Ё., & Халимжонова, Х. Х. (2026). ПРИЧИНЫ ВОЗНИКНОВЕНИЯ И РАННЯЯ ДИАГНОСТИКА ГЕМОРРАГИЧЕСКИХ ИНСУЛЬТОВ. Вестник Ассоциации Пульмонологов Центральной Азии, 18(13), 282-285.
6. Tadjenov, M., Sadikov, R., Musaeva, Y., & Kuranbaeva, S. (2016). The effectiveness of amantadine and dopamine in the treatment of Guillain-Barre syndrome. Parkinsonism & Related Disorders, 22, e90-e91.

7. Khasanova, N., Ernaeva, G., Kuranbaeva, S., & Rakhimbaeva, G. (2019). Cognitive impairments study in symptomatic epilepsy and their new medical-psychological principles in Uzbekistan. Journal of the Neurological Sciences, 405, 167-168.
8. Khamdamov, S. J., Akramova, D., Kuranbaeva, S., Shamsieva, U., Musaeva, Y., & Kalandarova, S. (2022). The role of vascular factors in Parkinson's disease and vascular parkinsonism (Doctoral dissertation, PRAGUE/CZECH REPUBLIC).
9. Muzaffar, Z., & Shirin, D. (2024). Damage to the nervous system due to HIV. Eurasian Journal of Technology and Innovation, 2(7), 39-47.
10. Satima, K., Satimniyazovich, A. N., & Khujanazarovna, K. S. (2015). Clinical and diagnostic features of the infectious lesions of the central nerve system in hiv-infected patients. European science review, (9-10), 73-75.
11. Расулова, М. Б., Расулова, Д. К., & Куранбаева, С. Р. (2020). Афазиялар тикланиш динамикасида логопедик машғулотлар ўрни.
12. Khamdamov, S. J., Akramova, D., Kuranbaeva, S., Shamsieva, U., Musaeva, Y., & Kalandarova, S. (2023). The role of vascular factors in Parkinson's disease and vascular parkinsonism. Parkinsonism & Related Disorders, 113.
13. Mihailovich, K. S., & Anatolievna, S. J. (2014). Timing of diagnosis of central nervous system neoplasms in Stavropol Krai based on Stavropol Krai Clinical Hospital database. European science review, (11-12), 26-28.
14. Alimova, S. A. (2021). The incidence and clinical features of otitis media in patients with hiv infection. Scientific progress, 2(5), 74-81.
15. Akramova, D., Rakhimbaeva, G., Kuranbaeva, S., Kalandarova, S., & Ibodov, B. (2025). The relationship between sleep disorders and fibrinogen levels in Parkinson's plus syndromes: results of a scientific study. Parkinsonism & Related Disorders, 134.

16. Shokirov, S., Khakimov, S., Mallaev, F., Rustambekova, S., Kalandarova, S., & Kuranbaeva, S. (2025). Features of indicators of neurological correlates in the acute period of stroke. Journal of the Neurological Sciences, 480.
17. Mallaev, F., Shokirov, S., Kalandarova, S., Rustambekova, S., Kuranbaeva, S., & Muxtarov, R. (2025). The role of neurohormones in the acute period of ischemic stroke. Journal of the Neurological Sciences, 480.
18. Schapel, G. J., Beran, R. G., Kennaway, D. L., McLoughney, J., & Matthews, C. D. (1995). Melatonin response in active epilepsy. Epilepsia, 36(1), 75-78.
19. Kalandarova, S., Rustambekova, S., Muratov, F., Kuranbaeva, S., Shokirov, S., Mallaev, F., & Usmanova, G. (2025, December). Clinical and neurophysiological features of sleep-associated epileptic seizures. In EPILEPSIA (Vol. 66, pp. S79-S80). 111 RIVER ST, HOBOKEN 07030-5774, NJ USA: WILEY.
20. Куранбаева, С. Р., Каландарова, С. Х., Сайфуллаева, Д. Б., & Шарафитдинова, С. А. (2026). АФАЗИЯ ПРИ ИШЕМИЧЕСКОМ ИНСУЛЬТЕ: СОВРЕМЕННЫЕ ПРЕДСТАВЛЕНИЯ О ПАТОГЕНЕЗЕ, ДИАГНОСТИКЕ И РЕАБИЛИТАЦИИ. ОСНОВЫ МЕДИЦИНЫ, 1(10), 152-155.
21. Куранбаева, С. Р., Каландарова, С. Х., Ганиева, Ш. Ё., & Халимжонова, Х. Х. (2026). ПРИЧИНЫ ВОЗНИКНОВЕНИЯ И РАННЯЯ ДИАГНОСТИКА ГЕМОРРАГИЧЕСКИХ ИНСУЛЬТОВ. Вестник Ассоциации Пульмонологов Центральной Азии, 18(13), 282-285.
22. Rakhimbaeva, G., Musaeva, Y., Musayev, S., Kalandarova, S., & Khomidov, T. (2026). ABSTRACT NUMBER: ESOC2026A1531 PROINFLAMMATORY CYTOKINES AND MATRIX METALLOPROTEINASE-9 ACTIVITY AS BIOMARKERS OF

COGNITIVE IMPAIRMENT IN HEMORRHAGIC STROKE. European Stroke Journal, 11(Suppl 1), i860.

23. Khamdamov, S. J., Akramova, D., Kuranbaeva, S., Shamsieva, U., Musaeva, Y., & Kalandarova, S. (2022). The role of vascular factors in Parkinson's disease and vascular parkinsonism (Doctoral dissertation, PRAGUE/CZECH REPUBLIC).
24. Satima, K., Satimniyazovich, A. N., & Khujanazarovna, K. S. (2015). Clinical and diagnostic features of the infectious lesions of the central nerve system in hiv-infected patients. European science review, (9-10), 73-75.
25. Khamdamov, S. J., Akramova, D., Kuranbaeva, S., Shamsieva, U., Musaeva, Y., & Kalandarova, S. (2023). The role of vascular factors in Parkinson's disease and vascular parkinsonism. Parkinsonism & Related Disorders, 113.
26. Kh, K. S. (2025). ELECTROENCEPHALOGRAPHIC FEATURES OF SLEEP-RELATED EPILEPTIC SEIZURES. Central Asian Journal of Medicine, (10), 65-67.
27. Касимова, Н. С., Маджидова, Ё. Н., Алиджанова, Д. А., & Юсупова, Д. М. (2016). Иммунологическая и аутоиммунная реактивность больных детей с инсультом. NATIONAL JOURNAL OF NEUROLOGY, (2 (10)), 21-25.
28. Алиджанова, Д. А., & Усманов, С. А. (2017). АМИНОФЕНИЛМАСЛЯННАЯ КИСЛОТА В КОМПЛЕКСНОМ ЛЕЧЕНИИ ВЕГЕТАТИВНЫХ ДИСФУНКЦИЙ У ДЕТЕЙ И ПОДРОСТКОВ. In ШКОЛА ВМ БЕХТЕРЕВА: ОТ ИСТОКОВ ДО СОВРЕМЕННОСТИ (pp. 184-184).
29. Kim, O., Madjidova, Y., Abidova, M., Hamidova, N., Abdullaeva, V., & Sattarov, T. (2021). Clinical-Neurological and neurocognitive indicators against the background of neuroprotective therapy in vertebro-basilar

insufficiency in patients with symptoms of cerebral venous dyscirculation. Annals of the Romanian Society for Cell Biology, 25(1), 315-323.

30. Усманов, С. А., & Алиджанова, Д. А. (2017). ОПТИМИЗАЦИЯ ТЕРАПИИ СИНДРОМА ВЕГЕТАТИВНЫХ ДИСФУНКЦИЙ У ДЕТЕЙ И ПОДРОСТКОВ. In Давиденковские чтения (pp. 361-361).
31. Алиджанова, Д. А., & Усманов, С. А. (2017). Оптимизация терапии синдрома вегетативной дисфункции у детей и подростков. In Доброхотовские чтения (pp. 179-180).
32. Алиджанова, Д. А., & Маджидова, Ё. Н. (2018). КЛИНИКО-НЕВРОЛОГИЧЕСКИЕ ОСОБЕННОСТИ И ИММУНОЛОГИЧЕСКИЕ АСПЕКТЫ МИГРЕНИ У ДЕТЕЙ (Обзор литературы). Журнал теоретической и клинической медицины, (3), 77-81.
33. Алиджанова, Д. А., Маджидова, Ё. Н., Азимова, Н. М., & Назарова, Ж. А. (2019). Спектр иммунных изменений при первичных головных болях у детей. Медицина: теория и практика, 4(S), 44-45.
34. Алиджанова, Д. А., & Кадирова, Р. М. (2026). ОСОБЕННОСТИ ДИСФУНКЦИЙ ВЕГЕТАТИВНОЙ НЕРВНОЙ СИСТЕМЫ У ДЕТЕЙ И ПОДРОСТКОВ ПРИ МИГРЕНИ. Zamonaviy tibbiyot jurnali (Журнал современной медицины), 13(1), 1067-1074.
35. Алиджанова, Д. А., Усманов, С. А., & Юсупова, Д. М. (2016). Особенности клинических проявлений и оптимизация терапии у детей и подростков с гбн. Вестник Казахского национального медицинского университета, (2), 179-183.
36. Нуриддинов, Э. З. (2019). Интернациональные особенности Узбекского народа в годы Великой Отечественной войны и на современном

этапе. Эшелоны идут на Восток. Эвакуация в Узбекистан в годы Великой Отечественной войны. Оренбург–Ташкент, 44-47.

37. Нуриддинов, Э. З. (2019). Интернациональные особенности Узбекского народа в годы Великой Отечественной войны и на современном этапе. Эшелоны идут на Восток. Эвакуация в Узбекистан в годы Великой Отечественной войны. Оренбург–Ташкент, 44-47.
38. Исламова, М. С., Сабиров, М. А., & Даминова, К. М. (2021). Лептин-перспектива для диагностики ренального поражения при ожирении.
39. Исламова, М., & Даминова, К. (2022). Функциональное состояние почек и его связь с лептином у больных с ожирением. Медицина и инновации, (2), 249-257.
40. Шоахмедова, К., Сабиров, М., & Бабаджанов, Ж. Б. (2019). Влияние хронической болезни почек на состояние полости рта. Stomatologiya, 3(76), 36-40.
41. Mukhamadovna, S. M., Umidovich, I. S., & Abdurasulovich, Y. S. (2019). Factors contributing to the formation of a complicated course of duodenal ulcer in persons of young age. Вопросы науки и образования, (6 (52)), 69-73.
42. Акбаров, А. Н., Шоахмедова, К. Н., & Сабиров, М. А. (2020). Влияние хронической болезни почек на состояние полости рта. Научные исследования, (3 (34)), 31-32.
43. Shamsiev, J., Islamova, D., & Islamova, S. (2020). Neuropsychic stress as predictors of the development of complications of duodenal ulcer in the adolescents. The Scientific Heritage, (48-2), 8-10.
44. Исламова, М. С., Сабиров, М. А., & Даминова, К. М. (2022). Роль лептина как биомаркера раннего повреждения почек у больных с ожирением. Лечащий врач, (1), 42-45.

45. Шадиева, Ш., & Гиязова, М. (2021). Коморбидность болезней пародонта и желудочно-кишечного тракта. Общество и инновации, 2(4/S), 424-428.
46. Самарходжаев, Б. Б., & Ахадова, М. А. (2013). Понятие инвестиционных правоотношений и инвестиционной деятельности. Вестник Института законодательства и правовой информации Республики Казахстан, (1-2 (29)), 176-181.
47. Xaydaraliyev, S. U., Sh, K. M., & Eshmurzayeva, A. A. (2026). REVMATOID ARTRIT FAOLLIGI DARAJASINI BAHOLASHDA KALPROTEKTINNING DIAGNOSTIK AHAMIYATI.
48. Eshmurzayeva, A. A., Sobirova, G. N., Xaydaraliyev, S. U., & Anvarxodjayeva, S. G. (2024). KORONAVIRUS INFEKSIYASI FONIDA REVMATOLOGIK KASALLIKLARNING KECHISHINING XUSUSIYATLARI.
49. Xaydaraliyev, S. U., Sh, K. M., & Eshmurzayeva, A. A. (2026). ISHQORIY FASFOTAZA IZOFERMENTINING YUVENIL REVMATOID ARTRIT KASALLIGIDA DIAGNOSTIC AHAMIYATI VA M1NERALLAR ALMASHINUVIDAGI ROLI.
50. XAYDARALIYEV, S., ESHMURZAYEVA, A., & MIRZAYEVA, S. X. (2026). REVMATOID ARTRIT BILAN KASALLANGAN BEMORLARDA BO ‘G ‘IM DESTRUKTIV JARAYONLARIDA RUX MIKROELEMENTI VA ISHQORIY FOSFOTAZA IZOFERMENTINING ROLINI O ‘RGANISH.
51. Xaydaraliyev, S. U., & SH, K. M. (2025). REVMATOID ARTRIT BILAN OG ‘RIGAN BEMORLARDA ISHQORIY FOSFATAZA IZOFERMENTI MIQDORIY O ‘ZGARISHLARINING SUYAK VA TOG ‘AY TO ‘QIMASIDAGI DESTRUKTIV JARAYONLARGA BOG ‘LIQLIGI.

52. Xadjimatova IX, K. M. S. (2026). ANTIOKSIDANTLAR QABUL QILAYOTGAN REVMATOID ARTRIT BILAN OG'RIGAN BEMORLARDA MATRIKS METALLOP ROTE I NAZ A 9 DARAJASINI TADQIQ ETISH.
53. Xadjimatova, I. X., Karimov, M. S., & Abzalova, D. A. (2025). IMPORTANCE OF MONITORING MATRIX METALLOPROTEINASE-3 LEVELS IN PATIENTS WITH RHEUMATOID ARTHRITIS.
54. Хаджиматова, И. Х., Каримов, М. Ш., & Норматова, К. Ш. (2025). ЗНАЧЕНИЕ ВНЕКЛЕТОЧНЫХ БИОХИМИЧЕСКИХ МАРКЕРОВ ПРИ РЕВМАТОИДНОМ АРТРИТЕ И ИХ ВЛИЯНИЕ НА ФУНКЦИЮ ПЕЧЕНИ. Журнал гуманитарных и естественных наук, (21 [2]), 171-174.
55. Xamidullayevna, X. I., & Shakirovich, K. M. (2025). РОЛЬ МАТРИКСНОЙ МЕТАЛЛОПРОТЕИНАЗЫ-3 В ПАТОГЕНЕЗЕ И КЛИНИЧЕСКОМ ТЕЧЕНИИ РЕВМАТОИДНОГО АРТРИТА.
56. Шакирович, К. М. Р., & Хаджиматова, И. Х. (2025). ДИАГНОСТИЧЕСКОЕ ЗНАЧЕНИЕ ММП-9 В НАРУШЕНИЯХ ПЕЧЁНОЧНОЙ ФУНКЦИИ У ПАЦИЕНТОВ С РЕВМАТОИДНЫМ АРТРИТОМ. Medical journal of Uzbekistan, 1(2), 188-193.
57. Хаджиматова, И. Х., & Каримов, М. Ш. (2025). РОЛЬ МАТРИКСНОЙ МЕТАЛЛОПРОТЕИНАЗЫ-9 И ПЕЧЁНОЧНЫХ ФЕРМЕНТОВ ПРИ РЕВМАТОИДНОМ АРТРИТЕ. Журнал гуманитарных и естественных наук, (22 [2]), 92-95.
58. Xadjimatova, I. X. (2025). STUDY OF CLINICAL MANIFESTATIONS OF RHEUMATOID ARTHRITIS IN PATIENTS WITH METABOLIC SYNDROME.

59. Хаджиматова, И. Х., & Каримов, М. Ш. (2025). КЛИНИЧЕСКИЕ ОСОБЕННОСТИ РЕВМАТИЗМА ПРИ МЕТАБОЛИЧЕСКОМ СИНДРОМЕ.
60. Karimov, M. S., & Khadjimatova, I. X. (2025). Metabolic Changes in Acute Rheumatic Fever.
61. Rajpurkar, P. et al. (2022). AI in health and medicine. Nature Medicine, 28(1), 31–38.
62. Shi, L. et al. (2021). Machine learning for outcome prediction of acute ischaemic stroke: A systematic review. BMJ Open, 11(6), e041951.
63. Topol, E.J. (2019). High-performance medicine. Nature Medicine, 25(1), 44–56.