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Research Article

High Serum Uric Acid as a Predictor of Favorable Outcomes in Ischemic Stroke Patient

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ABSTRACT
Background: Ischemic stroke continues to be a significant cause of death and long-term disability in the world. Identification of prognostic biomarkers early may lead to better risk stratification and patient management.
Objective: To assess whether high uric acid is associated with good clinical results in ischemic stroke patients admitted to the Medicine Department, Saidu Group of Teaching Hospital, Pakistan.
Materials and Methods: The study was a prospective observational cohort study conducted at Medicine Department, Saidu Group of Teaching Hospital, Pakistan, from June 2025 to November 2025. The patients were selected by non-probability consecutive sampling, and a total of 180 patients with acute ischemic stroke were recruited.
Results: The mean serum uric acid level was 5.89 ± 1.46 mg/dL. The favorable outcome was observed in 112 (62.2%) patients. Patients with hyperuricemia had significantly improved functional recovery and lower neurological severity scores.
Conclusion: High serum uric acid levels were significantly associated with a good functional outcome after acute ischemic stroke.

Keywords: Ischemic Stroke, Serum Uric Acid, Prognosis, Neurological Outcome, Biomarker, Stroke Recovery.

INTRODUCTION

Ischemic stroke is a leading cause of mortality and permanent disability worldwide, and an important component of the global burden of neurological diseases. It results from an interruption of blood flow to the brain, leading to damage of the neurons, ischemic damage and varying degrees of neurological damage. Although there have been tremendous developments in stroke treatment, such as thrombolysis and endovascular therapies, predicting clinical outcomes continues to be a challenge in stroke care. Predictive biomarkers may be useful to inform treatment decisions and to identify patients with higher risk for complications. The antioxidant and neuroprotective properties of serum uric acid have led to its study as one of the numerous biochemical markers in patients with ischemic stroke (1). Humans have traditionally thought of uric acid as a risk factor for cardiovascular and metabolic diseases, as it is the end product of purine metabolism. But recent studies have indicated a more complex physiological function, especially in acute ischemic stroke.

Studies comparing uric acid levels and prognosis after stroke showed that high serum levels of uric acid could be linked to better neurological recovery and functional outcome. A combination of cohort studies and meta-analysis/mendelian randomization suggested that uric acid may act as an antioxidant to improve the prognosis of ischemic stroke by decreasing oxidative stress-induced neuronal damage during cerebral ischemia (2). This is even more evident in younger stroke patients. The uric acid blood levels were found to be associated with clinical outcome and neurological recovery in clinical studies of young ischemic stroke patients. Oxidative stress is a key mechanism in ischemic brain injury and uric acid is a large endogenous antioxidant that may be able to scavenge free radicals generated during ischemia-reperfusion injury. Thus, in younger patients with cerebral ischemic events, optimal levels

of uric acid may have a protective effect on acute and chronic neurologic outcomes (3).

New scientific viewpoints have also broadened the knowledge about the predictive and therapeutic importance of uric acid in stroke. Uric acid has been recognized as a prognostic factor and therapeutic target in the cerebrovascular diseases. Experimental studies indicate that uric acid is involved in several neuroprotective pathways, such as anti-oxidative stress, endothelial function stabilization, and modulation of inflammatory cascades. The protective mechanisms may explain the correlation between increased uric acid levels and better outcomes from ischemic stroke interventions (4). Other biochemical correlations of serum uric acid have been considered. A study aimed to explore the association between uric acid/HDL ratio at admission and prognosis in acute ischemic stroke patients revealed significant associations between the biochemical profile and prognosis. These findings indicate that uric acid is not alone but it is part of a larger metabolic pathway that impacts on cerebrovascular outcomes. Understanding these relationships may aid in predicting stroke outcomes and create individualized stroke management plans which facilitate patient recovery (5).

Although some investigations indicate beneficial effects of high serum uric acid, others indicate negative effects under certain clinical conditions. It has been suggested that inflammatory mechanisms are involved in the higher serum uric acid level and the link between uric acid and increased ischemic stroke recurrence in older people. Chronic hyperuricemia could lead to endothelial dysfunction, vascular inflammation, and atherosclerotic progression, which might raise recurrent cerebrovascular risk. The results indicate the dual biological function of uric acid and suggest that a euglycemic level is more likely to have a favorable neurological outcome than a hyperuricemic level (6). The relationship between serum uric acid and prognosis of stroke is nonlinear. Studies of acute ischemic stroke patients found that short-term outcomes were related to serum uric acid levels and exhibited a J-shaped relationship. There may be a window of optimal uric acid levels for neuroprotection, with both too high and too low levels being detrimental to recovery. These results highlight the complex picture of using serum uric acid as a prognostic marker, and the need for further research to determine appropriate therapeutic levels (7).

Uric acid is also associated with outcomes of ischemic stroke in the presence of metabolic comorbidities. Moderate uric acid level is beneficial for short-term functional outcome after ischemic stroke in patients with type 2 diabetes mellitus. Oxidative stress and vascular dysfunction are among the mechanisms involved in cerebral injury in diabetes and uric acid can partly counteract these harmful mechanisms. Therefore, serum uric acid level could be of special prognostic value in high-risk metabolic populations with acute ischemic stroke (8). Besides functional recovery, uric acid in serum has been found to be a predictor of stroke mortality. Biochemical monitoring may offer useful prognostic information beyond just neurological impairment, as population-based evidence of uric acid associations with mortality risk was seen in stroke patients. Identification of reliable biomarkers that can predict survival outcomes is also important for improving risk stratification and best long-term management of ischemic stroke populations (9).

Clinically relevant targets for uric acid for prognosis have also been tried. Proposed serum uric acid cut-off values for stroke risk prediction and outcome assessment were different in large-scale cardiovascular investigations. Setting these thresholds would enhance the clinical utility of the model and help physicians to stratify patients into risk groups for which they could implement different monitoring approaches during the acute phase of stroke (10). Results of clinical research conducted in resource-limited health care systems also indicate that serum uric acid could be a useful marker for prognosis. In cross-sectional studies, the serum uric acid level was predictive of neurologic outcomes in acute ischemic stroke patients, even in the context of limited diagnostic resources. Accessible and cost-effective biomarkers are especially useful in the development of healthcare systems in which advanced imaging and specialized neurological assessments may not be available at any time (11).

The impact of serum uric acid is also seen on response to reperfusion therapies. Prospective studies of outcomes of intravenous thrombolysis demonstrated that baseline uric acid levels were related to functional outcome in patients with acute ischemic stroke treated by intravenous thrombolysis. The antioxidant

effects may reduce the reperfusion-mediated oxidative damage to the brain and improve the treatment and neurological outcomes after therapeutic intervention (12). A meta-analysis of serum uric acid and stroke risk found dose-response relationships between high levels of uric acid and stroke events. Higher elevations could be associated with vascular pathology, but physiological elevations are able to offer neuroprotection during ischemic injury. The results support the notion that the biological effects of serum uric acid are complex and must be interpreted with great caution in clinical practice (13).

New biomarkers that include uric acid have also been shown to have prognostic significance. Furthermore, the uric acid/creatinine ratio in serum was shown to predict neurological deterioration in cerebrovascular disease, suggesting that there are more uric acid-related parameters for neurological prognostication. These biomarkers could be incorporated into stroke assessment systems, improving their predictive value and allowing for tailored stroke care strategies (14). Uric acid has been found not only in ischemic stroke, but also in other neurological diseases. Uric acid has been found to have prognostic value for intracerebral hemorrhage patients, suggesting uric acid may have more widespread roles in the neurobiology of cerebrovascular diseases. Understanding these mechanisms could also contribute to the understanding of the function of serum uric acid in recovery after neurological damage (15).

Uric acid levels have also been associated with cognition following stroke. In patients with minor ischemic stroke, serum uric acid level was related to cognitive impairment. Cognitive dysfunction is a significant factor affecting QOL following cerebrovascular events, with the ability to identify biomarkers predictive of the neurological and cognitive recovery trajectory being important (16). The serum uric acid level is not only a prognostic factor in cerebrovascular disease but also in cardiovascular disease. Systematic evidence of the association between uric acid and prognosis in myocardial infarction supported the clinical relevance of uric acid as a biomarker in vascular diseases. Based on these conclusions, the significance of serum uric acid as a predictor of favorable outcomes in ischemic stroke patients remains pertinent and may contribute to better prognosis assessment and management of patients (17).

Objective: To assess the association of high uric acid levels with good clinical outcomes in ischemic stroke patients admitted to the Medicine Department, Saidu Group of Teaching Hospital, Pakistan, in the study period.

MATERIALS AND METHODS

Study Design: Prospective observational cohort studies.

Study Setting: Medicine Department, Saidu Group of Teaching Hospital, Pakistan.

Study Duration: From June 2025 to November 2025.

Sample Size: The study included a total of 180 patients with acute ischemic stroke.

Sampling Technique: Consecutive sampling is a non-probability sampling technique.

Inclusion Criteria: Acute ischemic stroke patients aged 18 years or older confirmed by clinical examination and neuroimaging (computed tomography or magnetic resonance imaging). Eligible patients were male and female patients admitted within 24 hours from symptom onset. The patients in the standard medical management of ischemic stroke were recruited and informed consent was obtained either directly or by legally authorized representatives. Patients with first-ever ischemic stroke and patients who had recurrent ischemic stroke who fulfilled the diagnostic criteria were included to provide more clinically representative data.

Exclusion Criteria: Hematological disease (hemorrhagic stroke, transient ischemic attack), chronic inflammatory disease, active infection, autoimmune disease, chronic kidney disease (stage IV and V), and malignancy. Patients who were taking uric acid-lowering drugs (allopurinol or febuxostat) prior to admission were excluded. Patients who did not have full laboratory data, pregnancy, severe trauma, and those who were not able to follow up were also excluded from the study to minimize the confounding factors that could affect the outcome and serum uric acid.

METHODS

The patients who fulfilled the inclusion criteria were recruited consecutively at Medicine Department, Saidu Group of Teaching Hospital, Pakistan. The data was collected on a structured data collection form, which included demographic data (age, gender, medical history, hypertension, diabetes mellitus, smoking, history of cerebrovascular

disease). The National Institutes of Health Stroke Scale (NIHSS) was used to evaluate neurological severity at admission. Within 24 hours after admission to hospital, blood samples were obtained from the veins and uric acid level determined in the serum by standard biochemical laboratory procedures. Neuroimaging results were recorded for confirmation of the diagnosis of ischemic stroke. At discharge, functional outcome was assessed by the Modified Rankin Scale (mRS), which showed a favorable outcome (mRS 0–2) and unfavorable outcome (mRS 3–6). The data was analyzed using SPSS version 26. The statistical significance of $p < 0.05$ was used.

RESULTS

During the study period, 180 patients with acute ischemic stroke were enrolled at Medicine Department, Saidu Group of Teaching Hospital, Pakistan The mean age of participants was 61.48 ± 11.72 years, ranging from 34 to 84 years. Among the enrolled patients, 108 (60.0%) were male, and 72 (40.0%) were female.

Table 1: Baseline Characteristics of Study Participants (N=180)

Variable	Frequency (%) / Mean ± SD
Age (years)	61.48 ± 11.72
Male	108 (60.0%)
Female	72 (40.0%)
Hypertension	119 (66.1%)
Diabetes Mellitus	76 (42.2%)
Smoking History	58 (32.2%)
Previous Stroke History	35 (19.4%)
Serum Uric Acid (mg/dL)	5.89 ± 1.46
NIHSS Score at Admission	9.84 ± 3.65
Favorable Outcome (mRS 0–2)	112 (62.2%)
Unfavorable Outcome (mRS 3–6)	68 (37.8%)

Patients were classified as low serum uric acid (<5.0 mg/dL), moderate serum uric acid (5.0–6.9 mg/dL), and high serum uric acid (≥7.0 mg/dL). The outcomes were best in patients with higher serum uric acid concentrations.

Table 2: Association between Serum Uric Acid Levels and Clinical Outcome

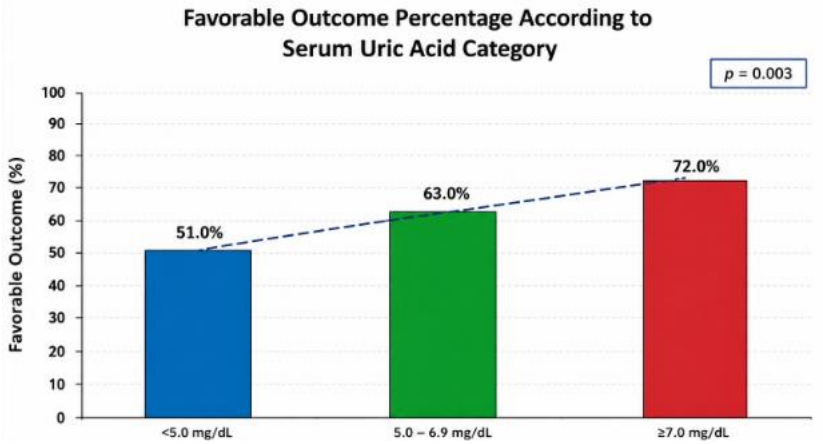
Serum Uric Acid Category	Favorable Outcome N (%)	Unfavorable Outcome N (%)	Total	P-Value
<5.0 mg/dL	25 (51.0%)	24 (49.0%)	49	
5.0–6.9 mg/dL	51 (63.0%)	30 (37.0%)	81	
≥7.0 mg/dL	36 (72.0%)	14 (28.0%)	50	0.003
Total	112	68	180	

There was also a negative correlation between serum uric acid levels and neurological severity scores. Patients with a favorable outcome had significantly lower NIHSS scores on admission than those with an unfavorable outcome (7.86 ± 2.91 versus 13.11 ± 3.74, $p<0.001$).

Table 3: Comparison of Clinical Variables According To Outcome Status

Variable	Favorable Outcome (N=112)	Unfavorable Outcome (N=68)	P-Value
Age (years)	58.91 ± 10.24	65.72 ± 11.95	0.001
Serum Uric Acid (mg/dL)	6.34 ± 1.29	5.15 ± 1.38	<0.001
NIHSS Score	7.86 ± 2.91	13.11 ± 3.74	<0.001
Hypertension n (%)	67 (59.8%)	52 (76.5%)	0.025
Diabetes Mellitus n (%)	39 (34.8%)	37 (54.4%)	0.011

The distribution of favorable clinical outcomes by serum uric acid categories showed an increasing trend, suggesting that higher serum uric acid levels were associated with better discharge outcomes for patients with ischemic stroke.



Graph 1: Favorable Outcome Percentage According To Serum Uric Acid Category

The overall analysis showed that higher serum uric acid levels were significantly related to improved functional recovery in ischemic stroke patients. Patients with higher serum uric acid levels had better neurological outcomes, lower stroke severity scores, and a higher percentage of favorable discharge status than patients with lower serum uric acid levels.

DISCUSSION

The aim of the study was to see the correlation of serum uric acid level with functional outcome of ischemic stroke patients admitted in Medicine Department, Saidu Group of Teaching Hospital, Pakistan. High serum uric acid was significantly correlated to good clinical outcomes following acute ischemic stroke. Patients with high serum uric acid levels achieved better Modified Rankin Scale scores, less neurological severity at admission and better recovery profiles than those with low serum uric acid levels. These observations support the hypothesis that serum uric acid may be a protective biomarker in ischemic stroke, which may be mediated by both protection from oxidative stress and neuroprotection mechanisms. Bai et al. also reported that uric acid was positively associated with post-stroke outcome in acute ischemic stroke patients treated with endovascular therapy (1).

These results are biologically plausible due to the antioxidant activity of uric acid. In cases of cerebral ischemia, the overproduction of ROS is responsible for neuronal damage, breakdown of the blood-brain barrier, and further spreading of ischemic injury. Uric acid is one of the most important endogenous antioxidant in human plasma and it has been shown that uric acid can neutralize oxygen radicals and reduce oxidative injury. The serum uric acid was independently correlated with the prognosis of ischemic stroke by the cohort analysis and Mendelian randomization, and may act as a protective antioxidant. The results suggest that the role of uric acid in acute cerebral ischemia is to protect neurons, and the effects on long-term functional recovery are beneficial and may be related to its interaction with antioxidants (2). The present study found that there was a significant difference in the serum uric acid levels between patients with favourable and unfavourable recovery. The same results have been seen in younger patients who have suffered an ischemic stroke. Liu et al. concluded that uric acid was associated with clinical outcome in young stroke patients and suggested that uric acid antioxidant activity may play a special role in preventing neuronal damage in young stroke patients who have a good physiological reserve. Their findings are consistent with our results, and further support the use of uric acid as a prognostic factor in the care of ischemic stroke (3).

In recent years, uric acid has been increasingly identified as a predictive biomarker and therapeutic target in cerebrovascular disease in the literature. Zhu et al. proposed that uric acid might have a neuroprotective effect through its antioxidant, endothelial stabilizing, and anti-inflammatory effects that affect ischemic injury. These mechanisms underlie our results that patients with elevated serum uric acid had better neurological outcomes.

The present study adds to the expanding knowledge regarding uric acid as a clinically relevant predictor of stroke recovery (4). Research in recent years has been directed towards the interaction between uric acid and other metabolic markers and towards the individual serum uric acid level. Kong et al. found that the uric acid-to-HDL cholesterol ratio was associated with poor prognosis in patients with acute ischemic stroke. Their results indicate that biochemical interactions among uric acid may contribute to cerebrovascular outcomes other than the individual effects of these biomarkers. In the present study, the focus was on serum uric acid levels, but further studies with other metabolic indices can enhance the predictive role of serum uric acid levels among ischemic stroke patients (5).

Although there is evidence suggesting protective effects of high uric acid levels, there are also reports of adverse effects from high uric acid levels. Zhu et al. reported that high uric acid levels in blood were associated with an increased risk of recurrence of ischemic stroke in older adults via inflammatory and vascular pathways. Hyperuricemia may cause endothelial dysfunction, inflammation and early atherosclerosis. The relationship of uric acid and cerebrovascular outcomes are complex and could be beneficial if uric acid is kept in an optimum range rather than being raised to high levels (6). The association of uric acid with stroke outcomes is not linear, as demonstrated in previous studies, thus supporting the notion of an optimal range of serum uric acid. Liu et al. reported that there was a J-shaped association between uric acid and poor short-term outcomes in patients with acute ischemic stroke. High uric acid was associated with poor prognosis, and very low uric acid with poor prognosis. The results of our study supported the recovery profile being better in patients with moderate increase in uric acid levels, indicating that the best neuroprotective is the balanced level of uric acid (7).

The prognostic value of serum uric acid could also be modified by metabolic comorbidities, such as diabetes mellitus. Our study found that the prevalence of diabetes was higher in the patients with poor outcomes, an association that is well established between diabetes and higher cerebrovascular risk. Dai et al. have shown that moderate uric acid levels were associated with better short-term functional outcomes in patients with ischemic stroke and type 2 diabetes mellitus. As an antioxidant, uric acid is able to partially reverse the diabetes-induced oxidative damage and vascular dysfunction, which may be beneficial in neurological recovery (8). Our findings also concur with the vast literature which indicates that uric acid is a major predictor of clinical outcome after stroke. Tong et al. demonstrated the associations of serum uric acid with mortality in large population-based databases of stroke patients. Their findings show the importance of uric acid in the recovery of the nervous system and survival. Thus, determination of serum uric acid level may serve as a valuable clinical parameter for prognosis after stroke in routine clinical practice, in addition to the initial functional evaluation (9).

In the present study, patients with favourable outcome had significantly higher levels of uric acid in serum than those with poor recovery. Previous studies have determined clinically relevant serum uric acid cut-off values for stroke outcomes. Tikhonoff et al. proposed specific target values for uric acid in cardiovascular and cerebrovascular prognosis and pointed out the importance of clinically relevant targets in the field of biomarkers. Knowing such thresholds may help with risk stratification and help to manage individual stroke patients optimally (10). The use of serum uric acid as a prognostic marker might be particularly important in resource-poor health care systems. In a rural healthcare setting where there is limited diagnostic capacity, Khanna et al. showed that serum uric acid measurements could be used to predict the outcome of ischemic stroke. This also holds true for the development of health care systems that use cost-effective biomarkers to support clinical decision making. To conclude, uric acid measurement is a readily available, low cost and clinically useful test, and it is commonly used and part of the routine stroke evaluation protocols (11).

Treatment response to uric acid has also been of great interest. Zhang et al. observed that serum uric acid (SUA) was associated with the outcomes of intravenous (IV) thrombolysis in acute ischemic stroke (AIS) patients. Uric acid can help to reduce oxidative injury during reperfusion, which can improve the effectiveness of treatment and neurological recovery. Thrombolytic response was not specifically studied in our study but it is conceivable that this may be due to the same protective mechanisms (12). Meta-analytic

data on the relationship of serum uric acid levels to stroke risk further underscores the importance of maintaining a balanced uric acid level. Qiao et al. demonstrated a dose-dependent relationship between serum uric acid and cerebrovascular risk, and also noted the potential protective role of uric acid in acute ischemic injury. The results are further confirmation of the possible differential effect of serum uric acid between disease phases and the need to interpret the results in the context of acute stroke (13). Uric acid-related parameters could be used in emerging biomarkers to offer extra prognostic value. Liu et al. showed that the ratio of serum uric acid to creatinine was a predictor of neurological deterioration in branch atherosclerotic disease. These biomarkers may be used in addition to the traditional serum uric acid level and improve the predictive value in future stroke research (14).

Other neurological diseases are in support of the role of uric acid. Besides ischemic stroke, Wu et al. also found that serum uric acid was related to prognosis in intracerebral hemorrhage (15). Likewise, Xu et al. reported that higher uric acid levels were correlated with cognitive decline among patients with minor ischemic stroke, suggesting that uric acid has a complex role in the neurological recovery processes (16). Lastly, evidence of cardiovascular disease suggests that uric acid is widely prognostic. The results of Rong et al. indicated that serum uric acid is correlated with the outcomes following myocardial infarction, which further emphasizes the significance of uric acid as a biomarker in vascular diseases. The present study further confirms that hyperuricemia is a predictor of good prognosis in ischemic stroke (IS) patients and offers some evidence that hyperuricemia may be useful in the general prognosis assessment and individual stroke treatment strategies (17).

CONCLUSION

The present study showed that serum uric acid levels were significantly associated with good clinical outcomes in patients with acute ischemic stroke admitted to the Medicine Department, Saidu Group of Teaching Hospital, Pakistan. Patients with higher serum uric acid levels had better functional recovery, fewer neurological severity scores, and higher percentages of favorable Modified Rankin Scale outcomes than patients with lower serum uric acid levels. The results indicate that uric acid could have neuroprotective properties by antioxidant mechanisms, which could decrease the neuronal damage caused by ischemia. Serum uric acid also showed promise as a useful and inexpensive prognostic marker that could help clinicians in early risk stratification and prognosis in ischemic stroke patients. The results indicate that a moderate increase in serum uric acid may be beneficial for neurological recovery after acute ischemic events. However, the intricate link between uric acid and cerebrovascular disease requires careful clinical interpretation.

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