Association of High-Sensitivity C-Reactive Protein and Random Blood Glucose with Neurological Deficit and Long- and Short-Term Prognosis in Young Stroke Patients: Postprint

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Abstract

Background: Stroke in young adults can lead to long-term disability, imposing a heavy burden on society and families. Studies have suggested that high-sensitivity C-reactive protein (hs-CRP) and stress hyperglycemia can increase the risk of ischemic stroke occurrence and poor prognosis, but to date, research evidence in the young stroke population is lacking.

Objective: This study aimed to investigate the correlations between hs-CRP and neurological deficits, as well as short-term and long-term prognosis, in young stroke patients.

Methods: This was a retrospective study that included first-time ischemic stroke patients aged 18-45 years who were admitted within 72 hours of onset. Patient demographics, vascular risk factors, and laboratory results were collected. The outcome measures were NIHSS score and mRS score at discharge, and 90-day mRS score. Multivariate logistic regression was used to analyze the relationships between hs-CRP, random blood glucose quartile groups, and neurological deficits (NIHSS score $>$ 4) as well as poor prognosis (mRS score 2-5).

Results: hs-CRP $>$ 1.18 mg/L was an independent risk factor for neurological deficits at discharge [OR for Q3: 2.86 (95% CI 1.56-5.22), P $<$ 0.01; OR for Q4: 2.99 (95% CI 1.63-5.50), P $<$ 0.01], poor short-term prognosis [OR for Q3: 2.14 (95% CI 1.25-3.66), P $<$ 0.01; OR for Q4: 2.80 (95% CI 1.62-4.83), P $<$ 0.01], and poor long-term prognosis [OR for Q3: 3.17 (95% CI 1.67-6.01), P $<$ 0.01; OR for Q4: 3.61 (95% CI 1.90-6.86), P $<$ 0.01]. Random blood glucose $>$ 7.01 mmol/L was associated with poor short-term prognosis [OR 2.05 (95%

CI 1.11-3.82), P = 0.02] and poor long-term prognosis [OR 2.62 (95% CI 1.31-5.24), P < 0.01], but not with neurological deficits at discharge [OR 1.84 (95% CI 0.95-3.57), P = 0.07]. Random blood glucose between 5.56 mmol/L and 7.01 mmol/L was independently associated only with poor long-term prognosis [OR 1.94 (95% CI 1.07-3.53), P = 0.03]. Consistent results were obtained after further excluding patients with pulmonary infection, urinary tract infection, and infectious diarrhea.

Conclusion: hs-CRP > 1.18 mg/L is an independent risk factor for poor short-term and long-term prognosis and neurological deficits at discharge in young stroke patients. Random blood glucose > 5.56 mmol/L is independently associated with poor long-term prognosis, while random blood glucose > 7.01 mmol/L is independently associated with poor short-term prognosis; neither is associated with neurological deficits at discharge.

Full Text

Association Between High-Sensitivity C-Reactive Protein, Random Glucose, and Neurological Deficit, Short-Term and Long-Term Prognosis in Young Stroke Patients

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Abstract

Background: Stroke in young adults can lead to long-term disability, imposing heavy social and family burdens. Studies have shown that high-sensitivity C-reactive protein (hs-CRP) and stress-induced hyperglycemia increase the risk of ischemic stroke and poor prognosis, but evidence remains lacking in young stroke populations.

Objective: This study investigated the associations of hs-CRP and admission random glucose with neurological deficit and short-term and long-term outcomes in young stroke patients.

Methods: This retrospective study included young patients (aged 18–45 years) with first-ever ischemic stroke admitted within 72 hours of onset. Demographic information, vascular risk factors, and laboratory results were collected. Outcome measures included NIHSS score at discharge and mRS scores at discharge and 90 days. Multivariate logistic regression was used to analyze the relationships between hs-CRP quartiles, random glucose quartiles, neurological deficit (NIHSS > 4), and poor prognosis (mRS 2–5).

Results: hs-CRP > 1.18 mg/L was an independent risk factor for neurological

deficit at discharge [Q3 = 2.86 (1.56–5.22), P < 0.01; Q4 = 2.99 (1.63–5.50), P < 0.01], short-term poor prognosis [Q3 = 2.14 (1.25–3.66), P < 0.01; Q4 = 2.80 (1.62–4.83), P < 0.01], and long-term poor prognosis [Q3 = 3.17 (1.67–6.01), P < 0.01; Q4 = 3.61 (1.90–6.86), P < 0.01]. Random glucose > 7.01 mmol/L was associated with short-term poor prognosis [OR 2.05 (95% CI 1.11–3.82), P = 0.02] and long-term poor prognosis [OR 2.62 (95% CI 1.31–5.24), P < 0.01], but not with neurological deficit at discharge [OR 1.84 (95% CI 0.95–3.57), P = 0.07]. Random glucose between 5.56 mmol/L and 7.01 mmol/L was independently associated only with long-term poor prognosis [OR 1.94 (95% CI 1.07–3.53), P = 0.03]. These results remained consistent after excluding patients with pulmonary infection, urinary tract infection, and infectious diarrhea.

Conclusion: hs-CRP > 1.18 mg/L is an independent risk factor for poor short-term and long-term prognosis and neurological deficit at discharge in young stroke patients. Random glucose > 5.56 mmol/L is independently associated with long-term poor prognosis, while random glucose > 7.01 mmol/L is independently associated with short-term poor prognosis, but not with neurological deficit at discharge.

Keywords: Young stroke; High-sensitivity C-reactive protein; Random glucose; Short-term prognosis; Long-term prognosis

Introduction

The incidence of stroke in young adults varies considerably across countries but has increased by 40% over the past decade. Approximately 10–20% of ischemic strokes occur in individuals aged 18–45 years, leading to long-term disability that severely impacts quality of life for patients and their families while creating substantial socioeconomic burdens. Compared with age- and sex-matched controls, young survivors of ischemic stroke face higher long-term mortality rates. Notably, the prevalence of stroke among young adults is highest in Asian populations, reaching 38.7%. Therefore, identifying risk factors for neurological deficit and poor prognosis in young Asian stroke patients is essential for screening high-risk individuals.

Stress-induced inflammatory responses play a critical role in the pathogenesis of ischemic stroke. C-reactive protein (CRP), an acute-phase reactant rapidly upregulated by inflammatory cytokines, serves as a sensitive marker of inflammation and atherosclerosis. Numerous prospective studies have demonstrated that CRP levels predict first-time and recurrent cerebrovascular events. Serum CRP levels differ across ischemic stroke etiological subtypes and correlate with large-artery atherosclerotic stroke both during the acute phase (within 10 days) and at 3-month follow-up. Elevated CRP levels also associate with poor outcomes during the acute phase and at 3 months. Additionally, stress hyperglycemia correlates with poor functional outcomes after mechanical thrombectomy or intravenous thrombolysis, hemorrhagic transformation, and stroke recurrence.

However, most studies have focused on middle-aged and elderly populations (mean age 50–70 years), whose stroke etiology distributions differ significantly from those of young patients. Through this retrospective study, we examined the relationships between hs-CRP, admission random glucose, neurological deficit, and short-term and long-term prognosis in young stroke patients to provide theoretical evidence regarding the impact of inflammatory and stress responses on stroke outcomes and to facilitate identification of high-risk young stroke patients.

1.1 Study Subjects

We retrospectively enrolled consecutive young patients with ischemic stroke admitted to the Neurology Center of Beijing Tiantan Hospital, Capital Medical University, between January 2019 and December 2021. Inclusion criteria were: (1) age 18–45 years; (2) first-ever stroke with admission within 72 hours of onset; and (3) diagnosis of cerebral infarction or transient ischemic attack according to the 2018 Chinese Guidelines for the Diagnosis and Treatment of Acute Ischemic Stroke. Exclusion criteria included: (1) missing hs-CRP or random glucose results; (2) intracerebral hemorrhage or venous cerebral infarction; (3) history of brain tumor or trauma, severe cardiac, hepatic, or renal disease; (4) other neurological disorders; and (5) pre-stroke mRS ≥ 2.

1.2 Clinical Data Collection

We collected demographic information (age, sex, BMI, TOAST classification), vascular risk factors (hypertension, diabetes, coronary artery disease, atrial fibrillation, smoking and alcohol consumption history), and laboratory results (hs-CRP, random glucose, estimated glomerular filtration rate [eGFR], triglycerides [TG], total cholesterol [TC], high-density lipoprotein cholesterol [HDL], low-density lipoprotein cholesterol [LDL], and glycated hemoglobin).

1.3 hs-CRP and Random Glucose Measurement

Both parameters were measured from blood samples collected immediately upon hospital admission. Five milliliters of blood were drawn, left at room temperature for 20 minutes, then centrifuged (3000 r/min for 20 minutes). The supernatant serum was collected and analyzed using a Hitachi LABOSPECT 008AS automatic biochemical analyzer. hs-CRP was measured by immunoturbidimetry using an Orion Diagnostica Oy kit, while random glucose was measured by the hexokinase method using a Sekisui Medical Technology (China) kit.

1.4 Outcome Measures

Neurological deficit was assessed using the NIHSS score at discharge, while short-term and long-term prognosis were evaluated using the modified Rankin Scale (mRS) at discharge and 90 days, respectively. Neurological deficit was defined

as NIHSS score > 4. Short-term poor prognosis was defined as mRS score 2–5 at discharge, and long-term poor prognosis as mRS score 2–5 at 90 days.

The NIHSS ranges from 0 to 42, with higher scores indicating more severe neurological impairment; a score > 4 suggests moderate-to-severe neurological deficit. The mRS ranges from 0 to 6, with scores 2–5 indicating poor prognosis and 6 indicating death: 0 = no symptoms; 1 = no significant disability despite symptoms, able to perform all usual activities; 2 = slight disability; unable to perform all previous activities but able to handle personal affairs without assistance; 3 = moderate disability; requires some help but can walk unassisted; 4 = moderately severe disability; unable to walk or attend to bodily needs without assistance; 5 = severe disability; bedridden, incontinent, requiring constant care; and 6 = death.

1.5 Statistical Analysis

Statistical analysis was performed using SPSS 23.0 software. Normally distributed continuous variables are presented as mean ± SD, non-normally distributed variables as median (interquartile range), and categorical variables as percentages. Continuous variables were compared using the Kruskal-Wallis test, and categorical variables using the ^{2} test or Fisher' s exact test. Multivariate logistic regression was performed with NIHSS score at discharge (> 4 vs. ≤ 4) and mRS scores at discharge and 90 days (2–5 vs. 0–1) as dependent variables to analyze the relationships between hs-CRP quartiles, random glucose, neurological deficit, and poor prognosis. Model 1 was adjusted for age and sex. Model 2 was adjusted for age, sex, BMI, smoking, alcohol consumption, hypertension, diabetes, coronary artery disease, atrial fibrillation, TOAST classification, triglycerides, total cholesterol, HDL, LDL, eGFR, glycated hemoglobin, and random glucose/hs-CRP. Model 3 added adjustment for pulmonary infection, urinary tract infection, and infectious diarrhea. Sensitivity analysis was performed after excluding patients with pulmonary infection, urinary tract infection, and infectious diarrhea, with adjustment for age, sex, BMI, smoking, alcohol consumption, hypertension, diabetes, coronary artery disease, atrial fibrillation, triglycerides, total cholesterol, HDL, LDL, eGFR, glycated hemoglobin, TOAST classification, and random glucose/hs-CRP. Statistical significance was set at two-sided $P < 0.05$.

2 Results

Based on inclusion and exclusion criteria, 630 patients were enrolled with a median age of 37 years; 530 (84.1%) were male. Patients were divided into four groups based on hs-CRP quartiles: Q1 (hs-CRP ≤ 0.49 mg/L), Q2 (0.49 < hs-CRP ≤ 1.18 mg/L), Q3 (1.18 < hs-CRP ≤ 3.68 mg/L), and Q4 (hs-CRP > 3.68 mg/L). Random glucose was similarly divided into quartiles: Q1 (≤ 4.70 mmol/L), Q2 (4.70–5.56 mmol/L), Q3 (5.56–7.01 mmol/L), and Q4 (> 7.01 mmol/L).

2.1 Baseline Characteristics

When grouped by hs-CRP quartiles, higher hs-CRP levels were associated with higher prevalence of hypertension, diabetes, and current smoking; greater likelihood of large-artery atherosclerosis etiology; and increased risk of pulmonary and urinary tract infections. Patients with elevated hs-CRP also had higher rates of neurological deficit at discharge and poor short-term and long-term prognosis. When hs-CRP exceeded 3.68 mg/L, the incidence of neurological deficit and poor prognosis reached 35–51% ($P < 0.05$). No significant differences were observed among the four groups in age, sex, BMI, coronary artery disease, atrial fibrillation, moderate-to-heavy alcohol consumption, triglycerides, total cholesterol, HDL, LDL, eGFR, glycated hemoglobin, or infectious diarrhea (Table 1).

2.2 Association Between hs-CRP and Neurological Deficit (NIHSS > 4), Short-Term Poor Prognosis (mRS 2–5 at Discharge), and Long-Term Poor Prognosis (mRS 2–5 at 90 Days)

After adjusting for age and sex (Model 1), logistic regression showed that compared with hs-CRP ≤ 0.49 mg/L, hs-CRP levels of 0.49–1.18 mg/L did not increase the risk of neurological deficit or poor short-term or long-term prognosis ($P > 0.05$). However, hs-CRP > 1.18 mg/L significantly increased the risk of neurological deficit and poor short-term and long-term prognosis by 2.12–3.84-fold. Specifically, hs-CRP > 3.68 mg/L increased the risk of neurological deficit [OR 3.07 (95% CI 1.76–5.34), $P < 0.01$], short-term poor prognosis [OR 3.41 (95% CI 2.09–5.57), $P < 0.01$], and long-term poor prognosis [OR 3.84 (95% CI 2.14–6.88), $P < 0.01$].

After further adjustment for age, sex, BMI, smoking, alcohol consumption, hypertension, diabetes, coronary artery disease, atrial fibrillation, TOAST classification, triglycerides, total cholesterol, HDL, LDL, eGFR, glycated hemoglobin, and random glucose (Model 2), similar results were obtained: hs-CRP > 1.18 mg/L significantly increased the risk of neurological deficit [Q3 = 2.88 (1.58–5.25), $P < 0.01$; Q4 = 3.32 (1.83–6.05), $P < 0.01$] and poor short-term [Q3 = 2.14 (1.26–3.64), $P < 0.01$; Q4 = 3.13 (1.83–5.34), $P < 0.01$] and long-term prognosis [Q3 = 3.07 (1.63–5.79), $P < 0.01$; Q4 = 4.01 (2.14–7.52), $P < 0.01$].

After additional adjustment for pulmonary infection, urinary tract infection, and infectious diarrhea (Model 3), elevated hs-CRP remained significantly associated with increased risk of neurological deficit [Q3 = 2.86 (1.56–5.22), $P < 0.01$; Q4 = 2.99 (1.63–5.50), $P < 0.01$], short-term poor prognosis [Q3 = 2.14 (1.25–3.66), $P < 0.01$; Q4 = 2.80 (1.62–4.83), $P < 0.01$], and long-term poor prognosis [Q3 = 3.17 (1.67–6.01), $P < 0.01$; Q4 = 3.61 (1.90–6.86), $P < 0.01$] (Table 2). Sensitivity analysis excluding patients with pulmonary infection, urinary tract infection, and infectious diarrhea (N = 592) confirmed these findings, showing that hs-CRP > 1.18 mg/L increased the risk of neurological deficit and poor short-term and long-term prognosis by 2.08–3.84-fold ($P < 0.01$), with higher

hs-CRP levels conferring greater risk (Table 4).

2.3 Association Between Random Glucose and Neurological Deficit (NIHSS > 4), Short-Term Poor Prognosis (mRS 2-5 at Discharge), and Long-Term Poor Prognosis (mRS 2-5 at 90 Days)

In Model 1, compared with random glucose ≤ 4.70 mmol/L, only random glucose > 7.01 mmol/L was associated with increased risk of short-term poor prognosis [OR 2.24 (95% CI 1.38–3.36), P < 0.01] and long-term poor prognosis [OR 2.19 (95% CI 1.25–3.85), P < 0.01], but not with neurological deficit at discharge (P = 0.09). Random glucose levels of 4.70–7.01 mmol/L were not associated with neurological deficit or poor short-term or long-term prognosis.

In Model 2, random glucose > 7.01 mmol/L was associated with increased risk of neurological deficit [OR 1.95 (95% CI 1.01–3.75), P = 0.04], short-term poor prognosis [OR 2.15 (95% CI 1.17–3.95), P = 0.01], and long-term poor prognosis [OR 2.74 (95% CI 1.38–5.44), P < 0.01]. Additionally, random glucose of 5.56–7.01 mmol/L increased the risk of long-term poor prognosis by 1.95-fold [OR 1.95 (95% CI 1.08–3.53), P = 0.03].

After further adjustment for pulmonary infection, urinary tract infection, and infectious diarrhea (Model 3), random glucose > 7.01 mmol/L remained associated with short-term poor prognosis [OR 2.05 (95% CI 1.11–3.82), P = 0.02] and long-term poor prognosis [OR 2.62 (95% CI 1.31–5.24), P < 0.01], but not with neurological deficit at discharge [OR 1.84 (95% CI 0.95–3.57), P = 0.07]. Random glucose of 5.56–7.01 mmol/L was independently associated only with long-term poor prognosis [OR 1.94 (95% CI 1.07–3.53), P = 0.03] (Table 3). Sensitivity analysis excluding patients with infections showed that random glucose > 7.01 mmol/L was significantly associated with short-term poor prognosis, increasing risk by 2.10-fold (P = 0.02), and that random glucose > 5.56 mmol/L increased the risk of long-term poor prognosis [Q3 = 1.96 (1.04–3.67), P = 0.04; Q4 = 2.86 (1.38–5.91), P < 0.01] (Table 4).

3 Discussion

Our study found that (1) patients with hs-CRP > 1.18 mg/L had higher risks of neurological deficit at discharge and poor short-term and long-term prognosis, independent of other factors, with risks increasing as hs-CRP levels rose; and (2) only random glucose > 7.01 mmol/L was independently associated with poor short-term and long-term prognosis in ischemic stroke, whereas before adjusting for or excluding infectious complications, it was associated with neurological deficit at discharge, but this association disappeared after further adjustment or removal of infectious complications.

Chronic inflammation plays a crucial role in the pathophysiology of atherosclerosis. In older adults, smokers, individuals with atherosclerotic lesions, psychological stress, diabetes, and obesity, CRP levels are elevated to varying degrees,

indicating that high CRP levels are associated with atherosclerotic plaque formation and acute thrombotic events. Elevated hs-CRP levels have been confirmed as an independent predictor of poor prognosis in patients with small-artery occlusion, though this association appears limited to patients under 75 years old. These findings suggest that CRP participates in the development and progression of atherosclerosis, causing inflammation-related endothelial dysfunction and platelet activation. Numerous studies have demonstrated associations between hs-CRP and poor outcomes and mortality after ischemic stroke. Elevated CRP within 24 hours of onset correlates with poor prognosis, and a study of 352 elderly acute ischemic stroke patients (median age 72 years) receiving intravenous thrombolysis found that, after excluding patients with infection, CRP levels were independent risk factors for poor short-term and long-term prognosis and in-hospital mortality. Serum CRP levels differ across etiological subtypes, correlating with large-artery atherosclerotic stroke both during the acute phase (within 10 days) and at 3-month follow-up. Additionally, acute-phase CRP levels independently predict 1-year mortality after ischemic stroke. However, most of these findings derive from middle-aged and elderly populations, with limited evidence in young adults. One study of 198 ischemic stroke patients aged 15–49 years (mean age 47.8 years) followed for 12 years found that CRP correlated with both short-term and long-term mortality, but lacked analysis of outcomes such as neurological deficit without death. Given the impact of disability on quality of life and social/family burden in young stroke patients, our study of 630 young stroke patients (median age 37 years) more comprehensively explored the relationship between hs-CRP levels and neurological deficit, discharge outcomes, and 90-day poor prognosis. We demonstrated that elevated hs-CRP significantly increased the risk of neurological deficit and poor short-term and long-term prognosis by 2.0–3.6-fold, with consistent results after excluding patients with infections. These findings suggest that in young stroke patients, elevated CRP not only increases mortality risk but also severely impairs neurological recovery. Early identification of high-risk individuals could improve clinical attention, enhance prognostic accuracy, and strengthen inflammation-targeted therapy to improve outcomes in young stroke patients.

Stress hyperglycemia is a relatively transient elevation of blood glucose secondary to neurohormonal disturbances and inflammation during critical illnesses such as stroke. Previous research indicates that acute stress hyperglycemia predicts increased risk of in-hospital death and poor functional recovery after ischemic stroke. A meta-analysis of ischemic stroke and stress hyperglycemia found that stress hyperglycemia in non-diabetic patients significantly increased mortality risk and elevated recurrent stroke risk in patients with minor stroke or TIA (median age 62.2 years). A Chinese study of 168,381 ischemic stroke patients (age 66.2 $\pm$ 10.7 years) suggested that stress hyperglycemia serves as a prognostic indicator in diabetic patients with acute ischemic stroke, as elevated glucose was associated with higher in-hospital mortality. However, some studies have found no association between stress hyperglycemia and stroke prognosis, including a prospective study of 790 acute ischemic stroke patients (age 79.4 $\pm$

6.8 years). These studies primarily focused on populations over 65 years old, leaving unclear the relationship between admission random glucose elevation and short-term and long-term poor prognosis and neurological deficit in young stroke patients. Our study confirms that elevated admission random glucose in young stroke patients increases the risk of short-term and long-term poor prognosis, but shows no significant association with neurological deficit at discharge.

Therefore, in young stroke patients, even without evidence of infection, elevated hs-CRP (> 1.18 mg/L) and random glucose (> 7.01 mmol/L) indicate increased risk of poor prognosis at discharge and 90 days, with elevated hs-CRP also serving as an independent risk factor for neurological deficit at discharge. Clinicians should pay greater attention to post-stress inflammatory responses to mitigate the risk of poor outcomes.

This study has several limitations. First, the male proportion was high at 84.1%, primarily because female patients more frequently have immune-related etiologies and are often diagnosed and treated at local hospitals before referral, resulting in lower representation in our cohort. Second, approximately 77.7% of our patients achieved mRS scores of 0–1 at 90 days, which is higher than rates of 55% and 68% reported in other young stroke studies. Our median admission NIHSS score was 3, suggesting that our cohort may have had less severe strokes or benefited from relatively good treatment quality.

4 Conclusion

hs-CRP > 1.18 mg/L is an independent risk factor for poor short-term and long-term prognosis and neurological deficit at discharge in young stroke patients. Random glucose > 5.56 mmol/L is independently associated with long-term poor prognosis, while random glucose > 7.01 mmol/L is independently associated with short-term poor prognosis, but not with neurological deficit at discharge.

5 Author Contributions

ZHAO Xingquan: Project administration, supervision, and review. JIA Jiaokun: Conceptualization, formal analysis, and original draft writing. LIU Yanfang: Investigation and data curation. GUO Jiahuang: Investigation and formal analysis.

7 References

1. Ekker M, Boot E, Singhal A, et al. Epidemiology, aetiology, and management of ischaemic stroke in young adults. The Lancet Neurology 2018; 17(9): 790-801.
2. Maaijwee N, Rutten-Jacobs L, Schaapsmeerders P, et al. Ischaemic stroke in young adults: risk factors and long-term consequences. Nature reviews Neurology 2014; 10(6): 315-25.

3. Ekker MS, Verhoeven JI, Vaartjes I, et al. Stroke incidence in young adults according to age, subtype, sex, and time trends. Neurology 2019; 92(21): e2444-e54.
4. Vangen-Lonne AM, Wilsgaard T, Johnsen SH, et al. Time trends in incidence and case fatality of ischemic stroke: the tromso study 1977-2010. Stroke 2015; 46(5): 1173-9.
5. Putaala J, Curtze S, Hiltunen S, et al. Causes of death and predictors of 5-year mortality in young adults after first-ever ischemic stroke: the Helsinki Young Stroke Registry. Stroke 2009; 40(8): 2698-703.
6. Jacob MA, Ekker MS, Allach Y, et al. Global Differences in Risk Factors, Etiology, and Outcome of Ischemic Stroke in Young Adults-A Worldwide Meta-analysis: The GOAL Initiative. Neurology 2022; 98(6): e573-e88.
7. Rost NS, Wolf PA, Kase CS, et al. Plasma concentration of C-reactive protein and risk of ischemic stroke and transient ischemic attack: the Framingham study. Stroke 2001; 32(11): 2575-9.
8. Bassuk SS, Rifai N, Ridker PM. High-sensitivity C-reactive protein: clinical importance. Curr Probl Cardiol 2004; 29(8): 9.
9. Kuo HK, Yen CJ, Chang CH, et al. Relation of C-reactive protein to stroke, cognitive disorders, and depression in the general population: systematic review and meta-analysis. Lancet Neurol 2005; 4(6): 371-80.
10. Di Napoli M, Papa F, Bocola V. Prognostic influence of increased C-reactive protein and fibrinogen levels in ischemic stroke. Stroke 2001; 32(1): 133-8.
11. Ladenvall C, Jood K, Blomstrand C, et al. Serum C-reactive protein concentration and genotype in relation to ischemic stroke subtype. Stroke 2006; 37(8): 2018-23.
12. Merlino G, Smeralda C, Gigli G, et al. Stress hyperglycemia is predictive of worse outcome in patients with acute ischemic stroke undergoing intravenous thrombolysis. Journal of thrombosis and thrombolysis 2021; 51(3): 789-97.
13. Yuan C, Chen S, Ruan Y, et al. The Stress Hyperglycemia Ratio is Associated with Hemorrhagic Transformation in Patients with Acute Ischemic Stroke. Clinical interventions in aging 2021; 16: 431-42.
14. Zhu B, Pan Y, Jing J, et al. Stress Hyperglycemia and Outcome of Non-diabetic Patients After Acute Ischemic Stroke. Frontiers in neurology 2019; 10: 1003.
15. Di Napoli M, Schwaninger M, Cappelli R, et al. Evaluation of C-reactive protein measurement for assessing the risk and prognosis in ischemic stroke: a statement for health care professionals from the CRP Pooling Project members. Stroke 2005; 36(6): 1316-29.
16. Qiu R, Gao Y, Hou D, et al. Association between hs-CRP Levels and the Outcomes of Patients with Small-Artery Occlusion. Frontiers in aging neuroscience 2016; 8: 191.
17. Shantikumar S, Grant PJ, Catto AJ, et al. Elevated C-reactive protein and long-term mortality after ischaemic stroke: relationship with markers of endothelial cell and platelet activation. Stroke 2009; 40(3): 977-9.

18. Muir KW, Weir CJ, Alwan W, et al. C-reactive protein and outcome after ischemic stroke. Stroke 1999; 30(5): 981-5.
19. Idicula TT, Brogger J, Naess H, et al. Admission C - reactive protein after acute ischemic stroke is associated with stroke severity and mortality: The 'Bergen stroke study' . Bmc Neurology 2009; 9.
20. Winbeck K, Poppert H, Etgen T, et al. Prognostic relevance of early serial C-reactive protein measurements after first ischemic stroke. Stroke 2002; 33(10): 2459-64.
21. Wnuk M, Derbisz J, Drabik L, et al. C-Reactive Protein and White Blood Cell Count in Non-Infective Acute Ischemic Stroke Patients Treated with Intravenous Thrombolysis. Journal of clinical medicine 2021; 10(8).
22. Dungan KM, Braithwaite SS, Preiser JC. Stress hyperglycaemia. Lancet 2009; 373(9677): 1798-807.
23. Capes S, Hunt D, Malmberg K, et al. Stress hyperglycemia and prognosis of stroke in nondiabetic and diabetic patients: a systematic overview. Stroke 2001; 32(10): 2426-32.
24. Pan Y, Cai X, Jing J, et al. Stress Hyperglycemia and Prognosis of Minor Ischemic Stroke and Transient Ischemic Attack: The CHANCE Study (Clopidogrel in High-Risk Patients With Acute Nondisabling Cerebrovascular Events). Stroke 2017; 48(11): 3006-11.
25. Mi D, Li Z, Gu H, et al. Stress hyperglycemia is associated with in-hospital mortality in patients with diabetes and acute ischemic stroke. CNS neuroscience & therapeutics 2022; 28(3): 372-81.
26. Tziomalos K, Dimitriou P, Bouziana S, et al. Stress hyperglycemia and acute ischemic stroke in-hospital outcome. Metabolism: clinical and experimental 2017; 67: 99-105.
27. Putaala J, Strbian D, Mustanoja S, et al. Functional outcome in young adult ischemic stroke: impact of lipoproteins. Acta neurologica Scandinavica 2013; 127(1): 61-9.
28. Nedeltchev K, der Maur T, Georgiadis D, et al. Ischaemic stroke in young adults: predictors of outcome and recurrence. Journal of neurology, neurosurgery, and psychiatry 2005; 76(2): 191-5.

Table 1 Baseline characteristics by hs-CRP quartiles

Table 2 Multivariate analysis of hs-CRP and neurological impairment at discharge (NIHSS > 4), poor prognosis (mRS 2–5) at discharge and 90 days

Table 3 Multivariate analysis of random glucose and neurological impairment at discharge (NIHSS > 4), poor prognosis (mRS 2–5) at discharge and 90 days

Table 4 Sensitivity analysis of hs-CRP, random glucose and neurological impairment at discharge (NIHSS > 4), poor prognosis (mRS 2–5) at discharge and 90 days

Note: Figure translations are in progress. See original paper for figures.