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ORIGINAL RESEARCH

Epidemiological and clinical characteristics of acute ischemic stroke patients in a war zone

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Abstract

Background: Acute ischemic stroke is a leading cause of mortality and long-term disability worldwide. In conflict-affected regions, timely diagnosis and guideline-based management are often compromised due to damaged infrastructure and limited healthcare resources. This study aimed to evaluate the demographic, clinical, laboratory, and radiological characteristics of patients with acute ischemic stroke admitted to a humanitarian hospital in northern Syria and to identify factors associated with adverse in-hospital outcomes. **Methods**: This retrospective observational study included adult patients ($\geq$18 years) diagnosed with acute ischemic stroke and admitted to the emergency department of Çobanbey Humanitarian and Technical Hospital between January 2023 and December 2024. Diagnosis was confirmed by clinical evaluation and brain computed tomography. Demographic data, comorbidities, presenting symptoms, laboratory and imaging findings, and in-hospital outcomes were recorded. The primary outcome was a composite of in-hospital mortality or intensive care unit (ICU) admission. Logistic regression analyses were performed. **Results**: A total of 136 patients were included, of whom 62 were female, with a mean age of 67 $\pm$ 14.6 years. Smoking prevalence was high (89%), while hypertension (37.5%) and diabetes mellitus (22.1%) were the most common comorbidities. Hemiparesis (62%), impaired consciousness (61%), and dysarthria (38%) were the most frequent presenting symptoms. Only 30.1% of patients presented within the 4.5-hour window for intravenous thrombolysis. Middle cerebral artery infarction was the most common radiological finding (43.4%). In-hospital mortality was 11.0%, and 44.1% of patients required ICU admission. In multivariate analysis, low serum thyroxine (T4) levels were independently associated with poor outcomes. **Conclusions**: Acute ischemic stroke management in conflict settings is limited by delayed presentation, restricted access to reperfusion therapies, and infrastructural constraints. Simple clinical and laboratory parameters may assist early risk stratification in resource-limited humanitarian hospitals.

Keywords

Acute ischemic stroke; Cerebrovascular infarction; Conflict; Humanitarian hospital

1. Introduction

Stroke remains a major global health problem and continues to be one of the leading causes of death and disability worldwide [1, 2]. The World Health Organization defines stroke as a clinical condition of sudden onset, leading to focal or global cerebral dysfunction lasting at least 24 hours or resulting in death, without any apparent cause other than vascular origin [3, 4]. Global data indicate that approximately 80–85% of strokes are ischemic, while 15–20% are hemorrhagic [1, 2, 4].

Although significant progress has been made in diagnostic protocols and treatments such as intravenous thrombolysis, these time-sensitive interventions require robust healthcare infrastructure and rapid access to care [4, 5]. In conflict zones, particularly in northern Syria, it has been reported that such conditions cannot be adequately ensured due to widespread infrastructure destruction and resource limitations caused by war [6].

Several international studies have shown that a large proportion of patients arrive at the emergency department after exceeding the critical 4.5-hour therapeutic window for intravenous thrombolysis [7, 8]. Similarly, a multicenter case-control study conducted in Syria demonstrated that modifiable risk factors and delayed presentation significantly increase the burden of stroke [9]. Furthermore, comorbidities such as hypertension, diabetes, and atrial fibrillation have been shown in various cohort studies to significantly elevate mortality and morbidity among stroke patients [9, 10].

Considering the chronic fragility of Syria's war-torn healthcare system, analyzing stroke cases in regional hospitals is not only of clinical interest but also constitutes a humanitarian necessity. Çobanbey Humanitarian and Technical Hospital, located in northern Syria, is one of the few organized healthcare institutions in the region providing tertiary-level intensive care services. This study aimed to retrospectively evaluate the demographic, clinical, laboratory, and radiological features of acute ischemic stroke patients admitted to the emergency department under the most basic available healthcare conditions. The findings aim to highlight stroke management under crisis conditions and contribute to the development of strategies that may improve clinical outcomes and reduce stroke-related mortality in similar settings.

This study aims to provide one of the few systematically collected datasets that describe detailed clinical, laboratory, and radiological characteristics of acute ischemic stroke patients treated at an active humanitarian hospital located near an ongoing conflict zone in northern Syria, thereby representing a unique contribution compared to previous reports from resource-limited settings.

2. Materials and methods

2.1 Study design and patient selection

This retrospective, observational study was conducted at Çobanbey Humanitarian and Technical Hospital, located in northern Syria. The study included adult patients (≥18 years) admitted to the emergency department between 01 January 2023, and 31 December 2024, who were initially diagnosed with acute stroke based on clinical findings and confirmed by neuroimaging with CT (Computed Tomography). Magnetic resonance imaging (MRI) was not available at Çobanbey Hospital. Patients admitted to the neurology ward or the intensive care unit (ICU) were included. Due to the lack of routine echocardiography, Holter monitoring, carotid Doppler ultrasonography, and CT/MR (Magnetic Resonance) in this humanitarian setting, reliable Trial of ORG 10172 in Acute Stroke Treatment (TOAST)-based etiologic subtyping was not feasible and was therefore not performed to avoid potential misclassification bias.

The National Institutes of Health Stroke Scale (NIHSS) could not be systematically applied due to the limited availability of trained neurological staff in this humanitarian setting. Therefore, the Glasgow Coma Scale (GCS), which was routinely recorded for all patients, was used as the primary neurological assessment tool.

Clinical management was provided according to locally available resources in this humanitarian hospital setting. Neurological assessment at admission was primarily based on the GCS, as systematic application of the National Institutes of Health Stroke Scale (NIHSS) was not feasible due to the limited availability of trained neurological staff. Standard medical management included antiplatelet therapy, statins, antihypertensive agents, and intravenous fluid support when indicated. Access to intravenous thrombolytic therapy was limited, and mechanical thrombectomy, as well as dedicated stroke unit care, were not available during the study period.

Time from symptom onset to hospital arrival was recorded and categorized as ≤3 hours, >3–6 hours, 6–12 hours, and >12 hours.

2.2 Exclusion criteria

Patients under 18 years of age, those diagnosed with non-stroke neurological conditions such as transient ischemic attack, subarachnoid hemorrhage, hypertensive intracerebral hemorrhage, epidural or subdural hematoma, outpatients not requiring hospitalization, and cases with incomplete or unverified records were excluded. Although both ischemic and hemorrhagic stroke cases were initially screened, hemorrhagic strokes (n = 4) were excluded due to insufficient and incomplete clinical documentation; therefore, the final analysis was restricted to acute ischemic stroke cases to avoid potential selection bias.

2.3 Data collection and outcome definition

Data were retrospectively retrieved from electronic medical records through the hospital's Health Information Management System (HIMS). The collected variables included age, sex, stroke type, presenting signs and symptoms, time of presentation, vital signs, laboratory parameters, length of hospital stay, treatment modality, place of admission (ward/ICU), discharge status, and in-hospital mortality. Symptom onset time was documented at triage based on patient or family interviews, and when available, verified using pre-hospital referral records. The time from symptom onset to hospital admission was determined using both patient or family interviews and available emergency department records; when discrepancies occurred, the earlier reported time was used to avoid underestimating pre-hospital delay. Because post-discharge follow-up was not feasible in this humanitarian setting, ICU transfer was used as a pragmatic indicator of early adverse outcome, as similarly adopted in studies conducted in conflict-affected or resource-limited environments. Because follow-up after discharge was not possible in this humanitarian setting, 3-month modified Rankin Scale (mRS) scores could not be obtained; therefore, ICU transfer—representing clinical deterioration within the hospital triage system—was used as a proxy adverse outcome.

2.4 Statistical analysis

Descriptive statistics were presented as means, standard deviations, medians, ranges (minimum–maximum), frequencies, and percentages. The distribution of numerical variables was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Missing laboratory values were infrequent (<5%), and no imputation was applied; analyses were performed using complete-case evaluation for each parameter. For normally distributed independent quantitative variables, the independent-samples *t*-test was performed, whereas the Mann-Whitney U test was used for non-normally distributed data. Categorical variables were compared using the Chi-square test, and Fisher's exact test was performed when assumptions were not met. All analyses were performed using IBM SPSS Statistics version 27.0 (Armonk, NY, USA), and a p-value of < 0.05 was considered statistically

significant.

Multivariable logistic regression analysis was performed to estimate odds ratios with 95% confidence intervals for the primary outcome. Given the relatively small sample size of 136 patients, the statistical power to detect smaller associations was limited; therefore, the multivariable models were considered exploratory and should be interpreted with caution. The regression model included age, sex, hypertension, diabetes mellitus, atrial fibrillation, systolic blood pressure, Glasgow Coma Scale score, alanine aminotransferase level, lymphocyte count, and thyroxine (T4) level.

3. Results

3.1 Demographic and clinical characteristics

A total of 136 patients were included in the study. The mean age was 67.2 ± 14.6 years (median: 70, range: 27–99), and 74 (54.4%) were male. Alcohol consumption was rare (5.9%), whereas smoking prevalence was strikingly high (89.0%). Comorbidities were present in 66.9% of cases, with hypertension being the most common (37.5%), followed by diabetes mellitus (22.1%) and heart failure (9.6%). Cardiac comorbidities included atrial fibrillation, ischemic heart disease, and heart failure.

At admission, GCS scores indicated that 15.4% of patients had severe impairment (3–8), 61.0% had moderate impairment (9–12), and 23.5% had mild/normal consciousness (13–15). Admissions peaked in January (25.0%) and February (16.2%). The most frequent presenting signs and symptoms were motor weakness (26.5%), altered consciousness (23.5%), poor general condition (21.3%), headache/dizziness (15.5%), speech disorder (11.0%), and seizure (2.2%) (Table 1). Only 30.1% of patients presented within the 4.5-hour therapeutic window.

TABLE 1. Demographic characteristics, comorbidities, and presenting findings.

Variable	Value
Age (yr)	67.2 ± 14.6 (median: 70; range: 27–99)
Gender, n (%)	
Male	74 (54.4)
Female	62 (45.6)
Alcohol use, n (%)	
No	128 (94.1)
Yes	8 (5.9)
Smoking, n (%)	
No	15 (11.0)
Yes	121 (89.0)
Any comorbidity, n (%)	
No	45 (33.1)
Yes	91 (66.9)
Specific comorbidities, n (%)	
Hypertension	51 (37.5)
Diabetes mellitus	30 (22.1)
Heart failure	13 (9.6)
COPD	4 (2.9)
Glasgow Coma Scale, n (%)	
3–8	21 (15.4)
9–12	83 (61.0)
13–15	32 (23.5)
Month of ED admission, n (%)	
January	34 (25.0)
February	22 (16.2)
March	11 (8.1)
April	7 (5.1)
May	8 (5.9)
June	15 (11.0)
July	8 (5.9)
August	3 (2.2)
September	3 (2.2)
October	6 (4.4)
November	6 (4.4)
December	13 (9.6)
Clinical findings on admission, n (%)	
General condition impairment	38 (21.3)
Motor weakness (left/right)	42 (26.5)
Altered level of consciousness	32 (23.5)
Speech disorder	20 (11.0)
Headache/dizziness	28 (15.5)
Seizure	4 (2.2)

Patients may present with multiple clinical findings; therefore, percentages were calculated over the total number of findings (n = 164), rather than the total number of patients. COPD, chronic obstructive pulmonary disease; ED, emergency department.

3.2 Neuroimaging findings and acute management

On brain CT, the most common lesion site was the middle cerebral artery (MCA) territory (43.4%), followed by the anterior cerebral artery (ACA, 30.9%) and posterior cerebral artery (PCA, 25.7%). Only three patients (2.2%) received intravenous thrombolysis, reflecting the severely limited availability of reperfusion therapy in this conflict-affected humanitarian setting. This is because tissue plasminogen activator (tPA) was unavailable in the hospital, and no stroke unit existed during the study period.

3.3 Clinical outcomes

Patients were followed during hospitalization until discharge or in-hospital death. In-hospital mortality was 11.0% (n = 15). Among survivors, 44.1% required ICU admission, 41.2% were admitted to the neurology ward, and 3.7% were discharged directly from the emergency department (Table 2). Causes of in-hospital mortality were classified as neurological (malignant MCA infarction, cerebral edema with herniation, aspiration pneumonia) and non-neurological (sepsis, cardiac arrest, multi-organ failure). All deaths recorded in this study occurred during the index hospitalization and were therefore classified as in-hospital mortality. However, no follow-up data on post-discharge deaths were available.

3.4 Univariate analysis of factors associated with mortality or ICU requirement

Comparisons between patients who developed mortality or required ICU admission versus those who did not reveal any significant differences in age, sex, alcohol use, or smoking ($p > 0.05$). Early presentation (≤4.5 hours) was significantly more common in the non-mortality/ICU group (50.8% *vs.* 13.3%, $p < 0.001$). Low GCS scores (3–8) were more frequent among those who developed mortality/ICU need (24.0% *vs.* 4.9%, $p = 0.007$). Overall, only 30.1% of patients presented to the emergency department within the 4.5-hour therapeutic window, while 69.9% arrived after this critical period. Early presentation (≤4.5 hours) was significantly less frequent among patients who developed post-stroke mortality or required ICU admission compared with those who did not (13.3% *vs.* 50.8%, $p < 0.001$) (Table 3).

3.5 Laboratory findings

Laboratory parameters showed that alanine aminotransferase (ALT) and lymphocyte counts were significantly lower in the mortality/ICU group ($p < 0.05$). Given the observational design and wartime constraints, GCS, ALT, lymphocyte count, and T4 levels should be interpreted as supportive prognostic indicators rather than definitive predictors and require validation in larger non-conflict populations. Serum T4 levels were also significantly lower in the mortality/ICU group ($p < 0.05$). No significant differences were found for AST, urea, creatinine, White Blood Cell (WBC), Red Blood Cell (RBC), hematocrit, Platelet (PLT), Mean Platelet Volume (MPV), Red Cell Distribution Width (RDW), neutrophils, monocytes, C-reactive Protein (CRP), magnesium, phosphorus, T3, or Thyroid-Stimulating Hormone (TSH) ($p > 0.05$). Although CRP levels were elevated overall, comparison between survivors and non-survivors showed no statistically significant difference (Table 4).

3.6 Multivariate logistic regression analyses

In the multivariate logistic regression model, none of the analyzed demographic or clinical variables demonstrated a statistically significant independent association with post-stroke mortality or ICU requirement (all $p > 0.05$). Age showed a borderline trend toward increased risk ($\beta = 0.028$, odds ratio (OR) = 1.03, 95% confidence interval (CI): 1.00–1.06, $p = 0.075$). Delayed emergency department presentation (>4.5 hours) was not independently associated with adverse outcomes after adjustment (OR = 0.94, 95% CI: 0.43–2.06, $p = 0.872$). The model's explanatory power was limited (Pseudo $R^2 = 0.042$), suggesting that additional unmeasured clinical or radiological factors may influence outcomes (Table 5).

In the multivariate logistic regression analysis including alanine aminotransferase (ALT), lymphocyte count, and thyroxine (T4), only serum T4 remained independently associated with post-stroke mortality or intensive care unit admission ($\beta = -1.161$, OR = 0.31, 95% CI: 0.12–0.86, $p = 0.024$). Patients with lower T4 levels had approximately a three-fold increased risk of adverse outcomes. ALT and lymphocyte count did not retain statistical significance after adjustment. These findings suggest that decreased thyroxine levels may reflect systemic stress severity, consistent with non-thyroidal illness ("low T3/T4 syndrome"), and may serve as a supportive prognostic marker in acute ischemic stroke (Table 6).

4. Discussion

The present findings highlight the decisive impact of early hospital admission on survival as well as the association between poor prognosis and low GCS scores, decreased ALT levels, lymphocytopenia, and reduced thyroxine (T4) levels in univariate analyses, while only thyroxine (T4) remained independently associated after multivariate adjustment. Stroke management under war conditions is severely constrained by delayed presentation, lack of access to reperfusion therapies, shortage of specialists, and infrastructural deficiencies. These limitations result in frequent missed therapeutic windows, higher mortality rates, and the inability to apply the widely emphasized principle that "time is brain". Consequently, ensuring safe transportation, strengthening mobile emergency medical teams, and utilizing easily accessible biomarkers (GCS, ALT, lymphocytes, T4) for early risk stratification are critical in conflict settings. Delayed hospital presentation was common in this cohort, reflecting the substantial barriers to timely stroke care in a conflict-affected humanitarian setting.

The median age of 70 years and male predominance (54.4%) observed in this cohort are consistent with previously published demographic studies. Samuthpongtorn *et al.* [11] (2021) also reported that elderly stroke patients have a higher comorbidity burden and more delayed healthcare access. While the present sample reflects comparable age trends, the additional challenges of security threats, infrastructural deficiencies, and transportation barriers unique to war zones further prolonged treatment access, contributing to frequent loss of the therapeutic window and increased mortality. Thus, although the present demographic findings align with the prior literature, they also underscore the aggravating role of war in stroke prognosis.

The extremely high smoking prevalence (89%) reinforces smoking as a strong and independent risk factor for stroke [12, 13]. Tobacco use accelerates atherosclerosis, induces endothelial dysfunction, increases oxidative stress, enhances inflammatory responses, and promotes platelet activation, thereby markedly elevating stroke risk. However, this extraordinary prevalence cannot be attributed solely to individual behavioral

TABLE 2. Clinical findings, imaging results, and post-admission clinical status.

	Min–Max	Median	Mean ± SD/n (%)
Time of Emergency Department Admission Due to Stroke			
08:00–16:00			65 (47.8%)
16:01–24:00			54 (39.7%)
00:01–07:59			17 (12.5%)
Speech			
Normal			27 (19.9%)
Aphasia			49 (36.0%)
Dysarthria			60 (44.1%)
Lateralizing neurodeficit			
(−)			16 (11.8%)
Left Hemiplegia			19 (14.0%)
Right Hemiplegia			18 (13.2%)
Left Hemiparesis			2 (1.5%)
Right Hemiparesis			57 (41.9%)
Quadriparesis			24 (17.6%)
Computed Tomography (CT) Result			
Posterior Cerebral Artery (PCA) Infarction			35 (25.7%)
Middle Cerebral Artery (MCA) Infarction			59 (43.4%)
Anterior Cerebral Artery (ACA) Infarction			42 (30.9%)
Systolic Blood Pressure (SBP), mmHg	70.0–193.0	140.0	140.4 ± 26.3
Diastolic Blood Pressure (DBP), mmHg	41.0–115.0	85.0	82.9 ± 15.8
Heart Rate (HR), beats/min	50.0–161.0	91.5	92.4 ± 15.2
Alanine Aminotransferase (ALT), U/L	7.0–87.0	19.0	23.8 ± 15.4
Aspartate Aminotransferase (AST), U/L	6.0–114.0	24.0	28.8 ± 18.3
Blood Urea Nitrogen (BUN), mg/dL	0.3–210.5	34.1	40.2 ± 29.0
Creatinine, mg/dL	0.3–10.8	1.0	1.2 ± 1.1
White Blood Cell Count (WBC), $\times 10^3/\mu L$	0.3–29.9	11.0	11.6 ± 5.0
Red Blood Cell Count (RBC), $\times 10^6/\mu L$	2.6–6.2	4.3	4.3 ± 0.7
Hematocrit (Hct), %	22.3–84.4	37.5	38.0 ± 7.0
Platelet Count (PLT), $\times 10^3/\mu L$	17.2–532.0	239.5	240.1 ± 87.0
Mean Platelet Volume (MPV), fL	6.0–15.1	8.6	8.8 ± 1.4
Red Cell Distribution Width (RDW), %	3.0–58.1	20.5	27.1 ± 13.5
Neutrophil Counts, $\times 10^3/\mu L$	2.2–27.4	8.6	9.0 ± 4.4
Lymphocyte Count, $\times 10^3/\mu L$	0.1–23.5	1.7	2.3 ± 3.3
Monocytes, $\times 10^3/\mu L$	0.0–5.4	0.6	0.7 ± 0.5
C-reactive Protein (CRP), mg/L	0.0–129.0	6.8	13.1 ± 17.1
Magnesium, mg/dL	0.9–4.7	1.9	2.0 ± 0.5
Phosphorus, mg/dL	1.2–5.7	3.5	3.4 ± 0.9
Triiodothyronine (T3), ng/mL	0.2–4.4	2.9	2.8 ± 0.8
Thyroxine (T4), µg/dL	0.3–2.9	1.2	1.3 ± 0.4
Thyroid-Stimulating Hormone (TSH), µIU/mL	0.1–5.6	1.0	1.1 ± 0.8
Patient Status After Stroke			
Death			15 (11.0%)
Intensive Care Unit (ICU) Admission			60 (44.1%)
Ward Admission			56 (41.2%)
Discharged from Emergency Department			5 (3.7%)

(−) indicates absence of a lateralizing neurological deficit. Min, minimum; Max, maximum; SD, standard deviation.

TABLE 3. Association between post-stroke mortality and need for intensive care unit with demographic and clinical variables.

	Absence of Post-stroke Mortality/ICU Requirement (n = 61)	Presence of Post-stroke Mortality/ICU Requirement (n = 75)	*p*-value
	Mean ± SD/n (%)	Mean ± SD/n (%)	
Age (yr)	65.9 ± 13.9 (Median-67.0)	68.3 ± 15.2 (Median-70.0)	0.351[t]
Sex			
Male	34 (55.7%)	40 (53.3%)	0.779[χ^2]
Female	27 (44.3%)	35 (46.7%)	
Alcohol Consumption			
No	59 (96.7%)	69 (92.0%)	0.245[χ^2]
Yes	2 (3.3%)	6 (8.0%)	
Smoking Status			
No	5 (8.2%)	10 (13.3%)	0.342[χ^2]
Yes	56 (91.8%)	65 (86.7%)	
Comorbidities			
No	19 (31.1%)	26 (34.7%)	0.664[χ^2]
Yes	42 (68.9%)	49 (65.3%)	
Glasgow Coma Scale (GCS)			
3–8	3 (4.9%)	18 (24.0%)	
9–12	40 (65.6%)	43 (57.3%)	**0.007**[χ^2]
13–15	18 (29.5%)	14 (18.7%)	
Speech Disturbance on Admission			
Normal	15 (24.6%)	12 (16.0%)	
Aphasia	23 (37.7%)	26 (34.7%)	0.306[χ^2]
Dysarthria	23 (37.7%)	37 (49.3%)	
Neurological Deficit on Admission			
None	10 (16.4%)	6 (8.0%)	
Left Hemiplegia	9 (14.8%)	10 (13.3%)	
Right Hemiplegia	8 (13.1%)	10 (13.3%)	0.131[χ^2]
Left Hemiparesis	0 (0.0%)	2 (2.7%)	
Right Hemiparesis	23 (37.7%)	34 (45.3%)	
Quadriparesis	11 (18.0%)	13 (17.3%)	
Cranial CT Findings			
Posterior Cerebral Artery (PCA) Infarction	21 (34.4%)	14 (18.7%)	
Middle Cerebral Artery (MCA) Infarction	23 (37.7%)	36 (48.0%)	0.111[χ^2]
Anterior Cerebral Artery (ACA) Infarction	17 (27.9%)	25 (33.3%)	
Time to Emergency Department Admission			
≤4.5 h	31 (50.8%)	10 (13.3%)	<**0.001**[χ^2]
>4.5 h	30 (49.2%)	65 (86.7%)	

[t], Independent samples t-test; [χ^2], Chi-square (χ^2) test. Bold values indicate statistically significant differences between groups ($p < 0.05$). CT, computed tomography; SD, standard deviation; ICU, intensive care unit.

TABLE 4. Association of mortality and need for intensive care unit with laboratory parameters and vital signs.

	Post-stroke Mortality/ICU (−) (n = 61)		Post-stroke Mortality/ICU (+) (n = 75)		*p*
	Mean ± SD/n (%)	Median	Mean ± SD/n (%)	Median	
Systolic Blood Pressure (SBP), mmHg	145.5 ± 24.2	140.0	136.2 ± 27.3	137.0	0.080^{m}
Diastolic Blood Pressure (DBP), mmHg	84.7 ± 14.6	85.0	81.4 ± 16.7	85.0	0.336^{m}
Heart Rate (HR), beats/min	90.3 ± 13.4	91.0	94.1 ± 16.4	92.0	0.258^{m}
Alanine Aminotransferase (ALT), U/L	25.5 ± 14.8	20.0	22.4 ± 15.9	17.0	**0.028**^{m}
Aspartate Aminotransferase (AST), U/L	28.3 ± 14.6	25.0	29.2 ± 20.9	24.0	0.639^{m}
Blood Urea Nitrogen (BUN), mg/dL	44.3 ± 34.6	38.5	36.8 ± 23.3	30.0	0.262^{m}
Creatinine, mg/dL	1.29 ± 1.44	0.9	1.16 ± 0.66	1.07	0.492^{m}
White Blood Cell Count (WBC), $\times10^3$/µL	11.6 ± 5.0	11.0	11.6 ± 5.1	11.0	0.995^{m}
Red Blood Cell Count (RBC), $\times10^6$/µL	4.3 ± 0.7	4.3	4.3 ± 0.7	4.3	0.432^{t}
Hematocrit (Hct), %	39.5 ± 8.5	38.9	36.8 ± 5.3	36.5	0.051^{m}
Platelet Count (PLT), $\times10^3$/µL	241.2 ± 85.7	243.0	239.2 ± 88.6	238.0	0.749^{m}
Mean Platelet Volume (MPV), fL	8.8 ± 1.0	8.9	8.8 ± 1.6	8.6	0.533^{m}
Red Cell Distribution Width (RDW), %	29.6 ± 14.0	22.7	25.1 ± 12.7	19.6	0.052^{m}
Neutrophil Count, $\times10^3$/µL	8.9 ± 4.7	7.8	9.0 ± 4.1	8.8	0.422^{m}
Lymphocyte Count, $\times10^3$/µL	2.9 ± 4.5	1.8	1.8 ± 1.9	1.5	**0.032**^{m}
Monocytes, $\times10^3$/µL	0.69 ± 0.67	0.57	0.68 ± 0.29	0.62	0.251^{m}
C-reactive Protein (CRP), mg/L	11.3 ± 13.6	5.2	14.6 ± 19.5	8.0	0.181^{m}
Magnesium, mg/dL	2.0 ± 0.4	2.0	2.0 ± 0.5	1.9	0.401^{m}
Phosphorus, mg/dL	3.4 ± 0.9	3.4	3.4 ± 0.9	3.5	0.666^{t}
Triiodothyronine (T3), ng/mL	2.9 ± 0.8	3.0	2.8 ± 0.8	2.9	0.606^{m}
Thyroxine (T4), µg/dL	1.34 ± 0.33	1.30	1.19 ± 0.40	1.15	**0.003**^{m}
Thyroid-Stimulating Hormone (TSH), µIU/mL	1.20 ± 0.91	1.05	1.09 ± 0.60	0.94	0.630^{m}

ICU, intensive care unit; SD, standard deviation; ^{t}, Student's t test; ^{m}, median. Bold values indicate statistically significant differences between groups ($p < 0.05$).

TABLE 5. Multivariate logistic regression analysis for post-stroke mortality/need for ICU.

Variable	B (Coefficient)	SE	*z*	*p*-value	OR	95% CI Lower	95% CI Upper
Age (yr)	0.028	0.015	1.78	0.075	1.03	1.00	1.06
Alcohol consumption (+)	−1.123	0.907	−1.24	0.216	0.33	0.06	1.92
Presence of comorbidity	−0.461	0.440	−1.05	0.295	0.63	0.27	1.49
Low GCS (≤12)	0.605	0.439	1.38	0.168	1.83	0.78	4.33
ED presentation (>4.5 h)	−0.064	0.401	−0.16	0.872	0.94	0.43	2.06

Model information: n = 136; Pseudo R^2 = 0.042; likelihood ratio test p = 0.243. The model converged after five iterations. The constant term was $\beta = -0.615$ (SE = 2.107), corresponding to an OR of 0.54 (95% CI 0.01–33.6; p = 0.77). SE, standard error; B, regression coefficient; OR, odds ratio; CI, confidence interval; GCS, Glasgow Coma Scale; ED, emergency department.

TABLE 6. Multivariate logistic regression analysis of laboratory parameters associated with post-stroke mortality or intensive care admission.

Variable	β	SE	Wald	*p*-value	OR	95% CI
ALT (U/L)	−0.009	0.012	0.53	0.465	0.99	0.97–1.02
Lymphocyte count ($\times10^3$/µL)	−0.114	0.074	2.35	0.125	0.89	0.77–1.03
Thyroxine (T4, µg/dL)	−1.161	0.513	5.13	0.024	0.31	0.12–0.86
Constant	2.131	0.726	8.62	0.003	-	-

Model information: n = 136; Omnibus test p = 0.016; Nagelkerke R^2 = 0.098; Hosmer-Lemeshow goodness-of-fit test p = 0.014. SE, standard error; OR, odds ratio; CI, confidence interval; ALT, alanine aminotransferase.

factors. Chronic stress, insecurity, lack of safety, insufficient social support, and the absence of cessation programs in war-torn regions likely contribute to this pattern. Therefore, smoking prevalence in the population not only represents an individual risk factor but also reflects the broader societal and systemic impacts of conflict. The unusually high smoking prevalence in the present cohort may reflect reporting bias (as smoking status was obtained through patient or family interview), the predominantly male study population—among whom smoking rates are culturally higher in northern Syria—and increased tobacco use associated with chronic stress and war-related psychological challenges. These factors should be considered when interpreting the external validity of the present findings.

Hypertension (37.5%) and diabetes mellitus (22.1%) were the most common comorbidities, consistent with the meta-analysis by Ryan *et al.* [14] demonstrating hypertension as the strongest predictor of both primary and recurrent strokes. The findings of the present study confirm hypertension as a universal risk factor while also highlighting how war-related barriers, such as limited medication supply, treatment non-adherence, and disrupted healthcare access, may exacerbate its effect on morbidity and mortality.

At presentation, 61.0% of patients had moderate (GCS 9–12) and 15.4% severe (GCS 3–8) impairment of consciousness supporting the well-established correlation between low GCS and poor prognosis reported in prior studies [15, 16]. In this cohort, lower GCS scores, lower ALT levels, lymphocytopenia, and lower thyroxine (T4) levels were associated with adverse outcomes, including post-stroke mortality or the need for intensive care. Given the observational design and the limited sample size, these variables should be regarded as practical, low-cost, supportive prognostic indicators rather than definitive or independent predictors. Importantly, these findings require external validation in larger cohorts, particularly in non-conflict-affected settings.

Another key finding was the prognostic significance of admission delay. Patients presenting within 4.5 hours had significantly better survival and lower ICU requirements ($p < 0.001$), reinforcing the well-established "time is brain" principle [8, 17, 18]. Similar findings have been reported in the studies from Somalia [7], Ethiopia [18], and India [19], where delayed admission worsened outcomes. In the present study, however, insecurity, transportation challenges, and underdeveloped emergency systems made this effect even more pronounced. Therefore, in conflict zones, strategies aimed at improving safe transport, mobile emergency capacity, and public awareness are essential.

Neuroimaging revealed middle cerebral artery (MCA) infarction as the most frequent lesion (43.4%), consistent with reports by Fan *et al.* [20] and Nogles & Galuska [21]. MCA strokes represent the most common subtype of large-vessel infarction, associated with severe disability and high mortality. Their predominance in the present cohort underscores their clinical and policy relevance, emphasizing the need for targeted strategies to mitigate associated health burdens in resource-limited settings.

Four parameters—low ALT, lymphocytopenia, low T4, and low GCS—were associated with poor outcomes in this cohort. These findings align with biological mechanisms previously described in the literature. Post-stroke immunosuppression increases infection susceptibility and worsens mortality, with lymphocytopenia strongly linked to poor prognosis [22], a relationship supported by the present data. Gkantzios *et al.* [23] demonstrated that low T4 levels in acute ischemic stroke patients significantly increased 12-month mortality, which the present results corroborate. Thus, thyroxine may serve as a simple yet effective early prognostic biomarker. Low ALT may reflect frailty, sarcopenia, malnutrition, reduced hepatic metabolic reserve, and diminished antioxidant capacity, all of which can impair physiological resilience during acute neurological injury. Similarly, low T4 levels are consistent with non-thyroidal illness syndrome (NTIS), characterized by reduced tissue thyroid hormone availability during critical illness, and have been associated with increased mortality and worse neurological outcomes in acute ischemic stroke populations.

Although multivariable logistic regression models were performed, the limited sample size reduced statistical power. Therefore, the observed associations should be interpreted as exploratory and hypothesis-generating rather than definitive, and require external validation in larger cohorts. While CRP levels were elevated in patients with poor outcomes, the difference was not statistically significant, consistent with heterogeneous findings in the literature. Zhang *et al.* [24] reported variable associations between inflammatory markers (neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, CRP) and short-term outcomes due to methodological differences. The present results reflect this inconsistency, suggesting that while CRP may indicate systemic inflammation, it lacks sensitivity as a short-term prognostic tool in resource-limited or war-affected environments.

Computed tomography (CT) was the sole neuroimaging modality available at Çobanbey Hospital, as MRI was not accessible. This limited the ability to detect small ischemic lesions or posterior fossa infarcts. Nevertheless, CT remains indispensable in these settings for the rapid differentiation of ischemic versus hemorrhagic strokes and for guiding acute management decisions. Previous reports indicate that non-contrast CT may miss up to 30–50% of posterior circulation infarcts in the early phase, suggesting that a proportion of the present sample may have been misclassified as having a "normal CT" despite clinical stroke features. Because MRI was not available, early ischemic changes and posterior circulation strokes may have been underdiagnosed, potentially leading to misclassification or underestimation of infarct severity, particularly in hyperacute presentations.

War directly affects both clinical care and operational aspects of healthcare. Destruction of transport infrastructure, attacks on healthcare facilities, shortages of physicians, and disrupted supply chains collectively worsen stroke outcomes. Such systemic collapse not only increases mortality but also undermines chronic disease management and preventive health services. War-related disruptions—including damaged transport routes, limited ambulance availability, population displacement, and reduced public education—significantly hinder access to reperfusion therapies and delay recognition of early stroke symptoms, contributing to prolonged pre-hospital intervals.

In summary, this study—one of the few examining acute ischemic stroke under war conditions—contributes valuable field-based evidence to the global stroke literature. The present findings suggest that, beyond classical cardiovascular risk factors, neurological status at admission and basic laboratory markers (GCS, ALT, lymphocytes, T4) are key prognostic indicators. These simple and accessible measures may serve as practical tools for early risk stratification and prognostic assessment in conflict and resource-limited settings.

Compared with regional Middle Eastern datasets and global stroke registries, the present cohort demonstrated longer admission delays, higher prevalence of modifiable vascular risk factors, markedly lower thrombolysis rates, and higher in-hospital mortality—patterns that likely reflect conflict-related barriers to acute stroke care. Compared with studies from non-conflict regions, the present cohort demonstrated substantially longer pre-hospital delays, markedly lower reperfusion therapy rates, and higher in-hospital mortality, underscoring the detrimental impact of war-related barriers on acute stroke care.

5. Limitations

This study has several limitations. First, its retrospective and single-center design limits the generalizability of the findings. The data were obtained from a humanitarian hospital operating under war conditions in northern Syria, where diagnostic and therapeutic facilities were severely restricted. MRI was not available, and only CT was used for diagnosis, which may have led to underdiagnosis of small ischemic or posterior circulation lesions. Second, long-term functional outcomes after hospital discharge could not be evaluated because follow-up data were unavailable. Third, due to the war environment, certain laboratory parameters and treatment details were missing in a small number of cases. Finally, the study population consisted exclusively of patients admitted to a single humanitarian hospital in northern Syria; therefore, regional variations in stroke epidemiology within the country may not be fully represented.

Despite these limitations, this study provides one of the few datasets describing acute ischemic stroke characteristics and prognostic determinants in a war-affected region, offering valuable insights for clinicians and humanitarian health planners.

Future research in conflict-affected and resource-limited settings should specifically investigate the prognostic and clinical differences between lacunar and non-lacunar ischemic strokes, as these subtypes exhibit distinct pathophysiological mechanisms and outcome profiles.

6. Conclusions

Acute ischemic stroke management in war-affected regions of northern Syria remains a major challenge due to delayed hospital admissions, limited diagnostic resources, and infrastructural collapse. The findings of the present study suggest that early hospital presentation is the strongest determinant of survival in patients with acute ischemic stroke, while low GCS scores, decreased ALT levels, lymphocytopenia, and low serum thyroxine (T4) levels were associated with poor outcomes, while only thyroxine (T4) remained an independent predictor after multivariate analysis. In resource-limited and conflict settings, where advanced imaging and laboratory capabilities are often unavailable, these simple clinical and biochemical parameters may serve as practical and cost-effective tools for early risk stratification. Strengthening emergency transport systems, public education, and early recognition programs is essential to improve stroke outcomes in similar humanitarian contexts.

Clinicians and humanitarian organizations should prioritize early identification of high-risk stroke patients using simple, low-cost indicators and strengthen mobile emergency response teams to reduce pre-hospital delays in conflict settings.

Future research should also explore access barriers to accessing reperfusion therapies in conflict settings, evaluate the effectiveness of pre-hospital triage systems and mobile emergency teams, and validate low-cost prognostic biomarkers such as GCS, ALT, lymphocyte count, and serum T4 levels, in larger multicenter populations.

Acute ischemic stroke management in war-affected regions of northern Syria remains a major challenge due to delayed hospital admissions, limited diagnostic resources, and infrastructural collapse. The findings of the present study suggest that early hospital presentation is strongly associated with survival in patients with acute ischemic stroke, while low GCS scores, decreased ALT levels, lymphocytopenia, and low serum thyroxine (T4) levels were associated with poor outcomes; however, after adjustment for potential confounders, only serum thyroxine (T4) remained an independent predictor in the multivariate analysis.

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AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

HG and ÖK—conceptualized the study and provided resources. HG—performed the software-related procedures, formal analysis, and project administration. AMG, YY, SG and ÖK—contributed to validation and writing—review and

editing. YY and SG—conducted the investigation. HG and AMG—responsible for data curation. AMG—prepared the original draft. AMG and YY—contributed to visualization. YY, SG and ÖK—supervised the study. HG, AMG, YY, SG and ÖK—contributed to the methodology. All authors have read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval for the study was obtained from the Harran University Ethics Committee (Protocol No: HRÜ/25.08.30; Date: 28 April 2025). Due to the retrospective design of the study and the use of anonymized medical records, the requirement for informed consent to participate was waived by the Ethics Committee.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. Although Özgür Karcıoğlu is currently serving on the Editorial Board of this journal, he was not involved in the peer review process of this article and had no access to any information related to its evaluation. The entire editorial responsibility for this manuscript was delegated to DSD.

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