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# Short-term functional outcomes of patients with acute intracerebral hemorrhage in the native and expatriate population

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**Objectives:** Functional outcomes in patients with intracerebral hemorrhage (ICH) have not been well characterized in the Middle East and North Africa Region. We report the 30 and 90-day clinical outcomes in the native and expatriate of Qatar with ICH.

**Methods:** We evaluated the Glasgow Coma Scale (GCS), NIHSS, and imaging in the Qatar Stroke Registry (2013–22). The outcome measures were a modified Rankin Scale (mRS) at 90 days and mortality at 30 and 90 days. Unfavorable outcome was defined as mRS of 4–6. We performed non-parametric ROC analyses to measure the concordance index (C-index) to assess the goodness-of-fit of ICH score for predicting 30 day and 90-day mortality and functional outcome.

**Results:** 1,660 patients (median age of 49 (41.5–58) years; male 83.1%, expatriates 77.5%) with ICH, including supratentorial deep in 65.2%, cortical in 16.2%, infratentorial 16% and primary intraventricular in 2.5% were studied. The median baseline ICH volume was 7.5 (3.2–15.8) ml. An unfavorable outcome was seen in 673 (40.5%) patients at 90 days. The unfavorable 90-day outcome (mRS 4–6) was 49.2% in the native population vs. 44.4% in Africans, 39.0% in South Asian, 35.3% in Far Eastern, and 7.7% in Caucasians,  $p < 0.001$ . Mortality at 30 days and 90 days was 10.4 and 15.1%. Increasing age [OR (95% CI), 1.02 (1.00–1.03)], lower GCS [0.77 (0.73–0.80)], prior use of antiplatelet medications [1.82 (1.19–2.08)], higher ICH volume [1.03 (1.02–1.04)], and presence of any intraventricular hemorrhage [1.57(1.19–2.08)], were associated with unfavorable outcome.

**Conclusion:** In this relatively younger ICH cohort more than 75% were expatriates. The ICH volume, 90-day unfavorable outcome and mortality was lower in the expatriates compared to the local Arab population, likely related to the younger age and smaller size of the hemorrhages. Prognostic scoring systems may have to be modified in this population to avoid early withdrawal of care.

## KEYWORDS

hemorrhagic stroke, outcome, major adverse cardiovascular events, mortality, hematoma volume, ICH score

## Introduction

Despite improvements in medical and surgical therapies, acute intracerebral hemorrhage (ICH) carries a grave prognosis (1), with a 30-day mortality between 30–55% and fewer than 20% patients are functionally independent 6 months (2–5). Several tools are used to predict mortality and functional outcome following an ICH (6–11) with the ICH-score being one of the most common in clinical practice (6). A recent meta-analysis of 55 studies reported that ICH-score, while having a good discrimination with low scores, overestimated mortality with higher scores (12).

The clinical impact of ICH appears disproportionately high among lower-resource populations (13). In US-based studies, ICH incidence has been reported to be  $\approx$ 1.6-fold greater among Black and Mexican (13). Internationally, ICH incidence is substantially higher in low-income countries and comprises  $\approx$  18% of all strokes (2–4). There are a few reports outlining prognosis of ICH from low resource countries (14–25). The number of patients in such series are small (19–22, 24), and the information collected retrospectively (18, 22, 23) making prediction modelling difficult to study. In a study from Netherlands, comparing the prognosis of ICH in ethnic populations, Surinamese men and women had higher rates if ICH and ischemic stroke compared to stroke patients from Morocco, Turkey, and the local Dutch population (26). In Scotland, the rates of ischemic stroke and ICH was higher in South Asian and Chinese compared to the White European origin subgroups (27).

In order to study admission trends, risk factors and prognosis in a large multiethnic population of patients from native (Arabs), and expatriates (South Asian, Southeast Asian), we investigated primary ICH admissions in the tertiary care centre in Qatar. We aimed to evaluate the outcome and prognosis in patients with ICH.

## Methods

The Qatar Stroke Database was established in March 2013 at the Hamad General Hospital (HGH), Doha. All data on patients with suspected acute stroke, including transient ischemic attacks (TIAs), cerebral infarction, stroke mimics, ICH and cerebral venous thrombosis (CVT) are entered prospectively into the registry (28–32). Depending on the severity and location of the ICH, patients are admitted to the stroke ward, ICU or neurosurgery.

For inclusion in the study, the following criteria were used: A diagnosis of ICH that was proven by imaging and related to hypertension or amyloid angiopathy. Patients with primary ventricular ICH were included but hemorrhages related to AVMs or aneurysms were excluded. We also excluded ICH related to trauma, hemorrhagic transformation of an ischemic infarction and systemic coagulopathy. Patients with primary subdural hemorrhage and subarachnoid hemorrhage were also excluded.

## Patient characteristics

Patient characteristics including age, sex, nationality, medical comorbidities, and prior medication were recorded. Ethnicity was defined based on social groups sharing cultural and language traits within the broad categories of Native Residents (Qatari and non-Qatari Arabs), South Asians (Indian, Pakistani, Bangladeshi,

Sri Lankans, Nepalese and Myanmar) and the Southeast Asians (predominantly from Philippines). Data collected included pre-stroke modified Rankin scale (mRS), NIH Stroke Scale (NIHSS) score at admission, length of stay (LoS) in ED, LoS in the stroke ward (SW), general medical ward (GMW), neurosurgical ward or the ICH. The most recent population statistics from Qatar shows the local Qatari population to be 360,000 (11.6%). In the expatriates 2,760,000 (88.4%), South East Asians comprise the largest group comprising 1,680,000 (46.6%) followed by non-Qatari Arabs 535,000 (17.1%) and individuals from Philippines 236,000 (7.6%).

## Patient and public involvement

Patients or the public WERE NOT involved in the design, or conduct, or reporting, or dissemination plans of our research.

## Radiological variables

Patients' plain head CT scans were analyzed to identify the following data: location (cortical, basal ganglia, thalamus, brainstem or cerebellum), ICH volume (cm<sup>3</sup>) measured using the method with the largest length in three dimensions divided by two (equation:  $ABC/2$ ); presence or absence of intraventricular hemorrhage IVH. For the purpose of the present study, we combined the location of the hematoma in the basal ganglion and thalamus. Our main objective for the localization was to compare prognosis in patients with cortical, "deep" sub-cortical and brainstem hemorrhages. We did not use any cut-offs for the size of the hematoma in the study populations.

## Clinical scores and outcome measures

All patients had Glasgow Coma Scale (GCS) measured at admission and regularly during admission. The primary outcome measures were unfavorable mRS (4–6) at 90-day, 30-day and 90-day mortality. We also compared good outcome at 30-day and 90-days. Good outcome was defined as an mRS of 0–3. As a secondary objective, we also evaluated the favorable outcome as mRS of 0–2. This data is shown in [Supplementary Table S1](#). The 30-day and 90-day data was collected by trained study coordinators by in person visits or via telephone assessments. The ICH-score was used to measure prognosis at admission. The ICH Score was the sum of individual points assigned as follows: GCS score 3 to 4 (=2 points), 5 to 12 (=1), 13 to 15 (=0); age 80-years yes (=1), no (=0); infratentorial origin yes (=1), no (=0); ICH volume > 30 cm<sup>3</sup> (=1), < 30 cm<sup>3</sup> (=0); and intraventricular hemorrhage yes (=1), no (=0) (6).

We have previously shown that the percentage of patients with diabetes is high in the local and expatriate population in Qatar (28–32). An additional objective of our analysis was to evaluate the presence of diabetes on the prognosis in our ICH population.

## Statistics

Continuous variables (age, systolic BP, diastolic BP, NIHSS, GCS, BMI and ICH volume) are presented as median values with interquartile range. Categorical variables (sex, residential status, mode

of arrival to the hospital, medical comorbidities, concomitant medications, hemorrhage location, ICH score, hospital admission status, and discharge disposition) are presented as counts and percentages. The study population was divided in two groups patients with favorable (mRS 0–3) and unfavorable (mRS 4–6) 90-day outcomes. Unadjusted univariable binary logistic regression analyses were performed to assess differences in continuous variables. The chi-square test was employed to compare categorical variables between groups. Variables with a  $p$ -value  $<0.05$  were used for regression analyses. Multivariable binary logistic regression analyses were used to assess the effects of the individual predictors with respect to 30-day, 90-day mortality and 90-day functional outcome. We also performed non-parametric receiver operator curve (ROC) analyses to measure the area under the curve (AUC) for all the variables used in the multivariable logistic regression analysis. We performed non-parametric ROC analyses to measure the concordance index (C-index) to assess the goodness-of-fit of ICH score for predicting 30-day, 90-day mortality and functional outcome at 90 days. All statistical analysis was performed using STATA 18.0 BE (StatCorp LLC Texas, United States).

The study was approved by the Committee for Human Ethics Research, Academic Health Service at HMC (MRC-01-18-102).

## Results

### Overall results

1,660 patients with primary ICH were available for analysis. As shown in [Figure 1](#), ICH represented 14.8% (1,674/11338) patients

with final diagnosis of stroke. The median (IQR) age was 49 (41.5–58) years, men were (1,379, 83.1%) and expatriates were (1,286, 77.5%).

The details of the clinical features, risk factors, imaging, NIHSS and GCS at admission, ICH score, location and volume, admission location, and surgical intervention are summarized in [Table 1](#). We compared the variables in two groups: favorable outcome (mRS 0–3) versus unfavorable outcome (mRS 4–6) at 90 days ([Figure 2](#)). The comparison of mRS 0–2 vs. 3–6 is shown in [Supplementary Table S4](#). A favorable outcome was seen in 987 (59.5%). The better outcome in men compared to women may be related to the relatively young age of the male (48, 41–57 years) patients compared to female (53, 44–66 years, OR 0.96 95%CI 0.95–0.97). The older women reflect the higher percentage of native residents (125, 33.4%) compared to expatriate women (156, 12.1%, OR 3.6 95%CI 2.7–4.8) in the study population.

At 30 days 1,487 (89.6%) of patients were alive and 173 (10.4%) died. Most of the deaths were recorded during the hospitalization 156 (9.4%). The mortality at 90 days increased to 251 (15.1%), predominantly males (202/251, 80.5%).

Favorable outcome was seen in 59.5% of patients. Individuals with a favorable outcome were significantly younger, and had lower random glucose levels, lower NIHSS and higher GCS scores as shown in [Table 1](#). Patients with favorable outcome were more likely to have smaller ICH volume on the initial imaging and supratentorial location. Active smoking and dyslipidemia, for unexplainable reasons, were more common in patients with a favorable outcome. The relationship of treatment including decompression surgery and hematoma evacuation is shown in [Table 1](#).

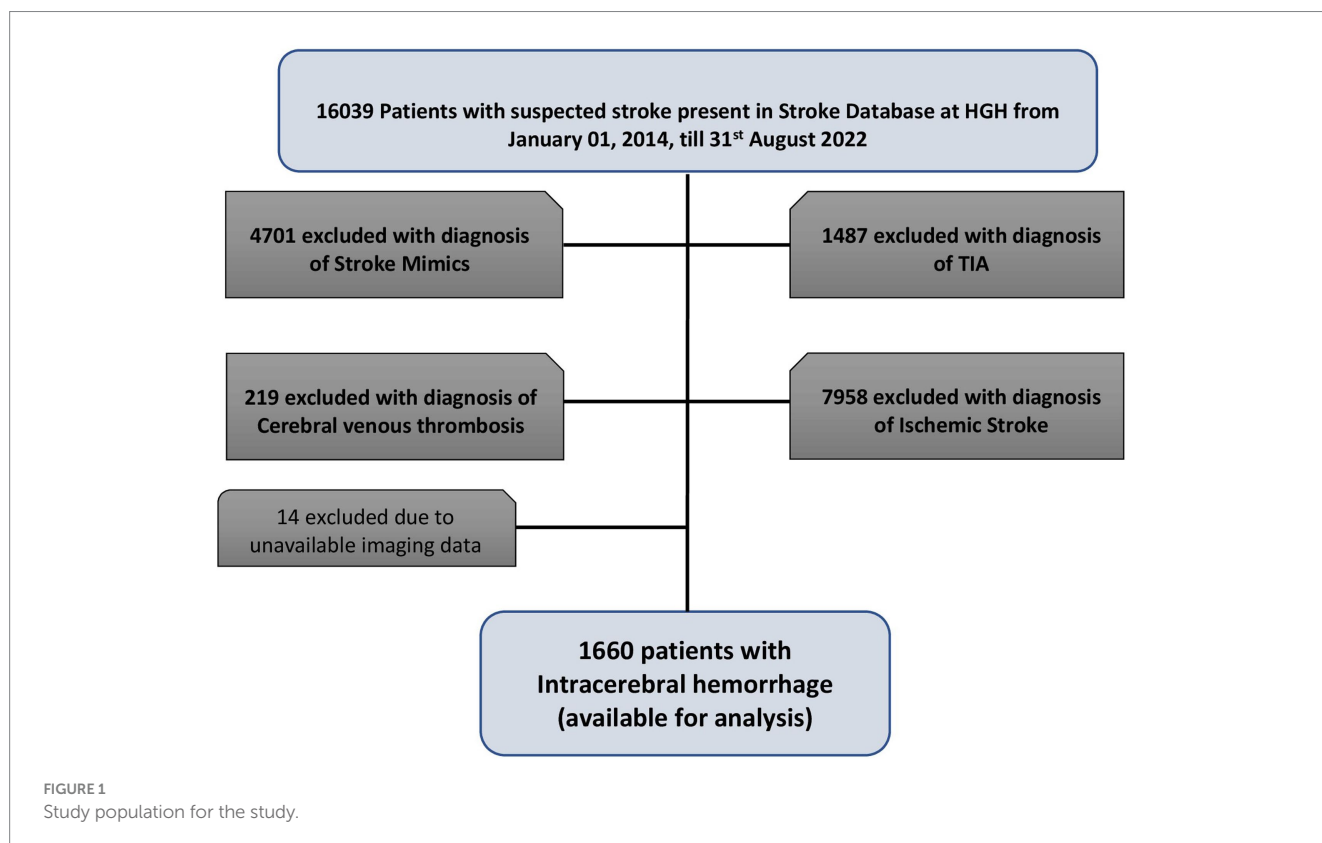


TABLE 1 Comparison of features related in ICH patients as defined by favorable (mRS 0–3) and unfavorable (mRS 4–6) outcome.

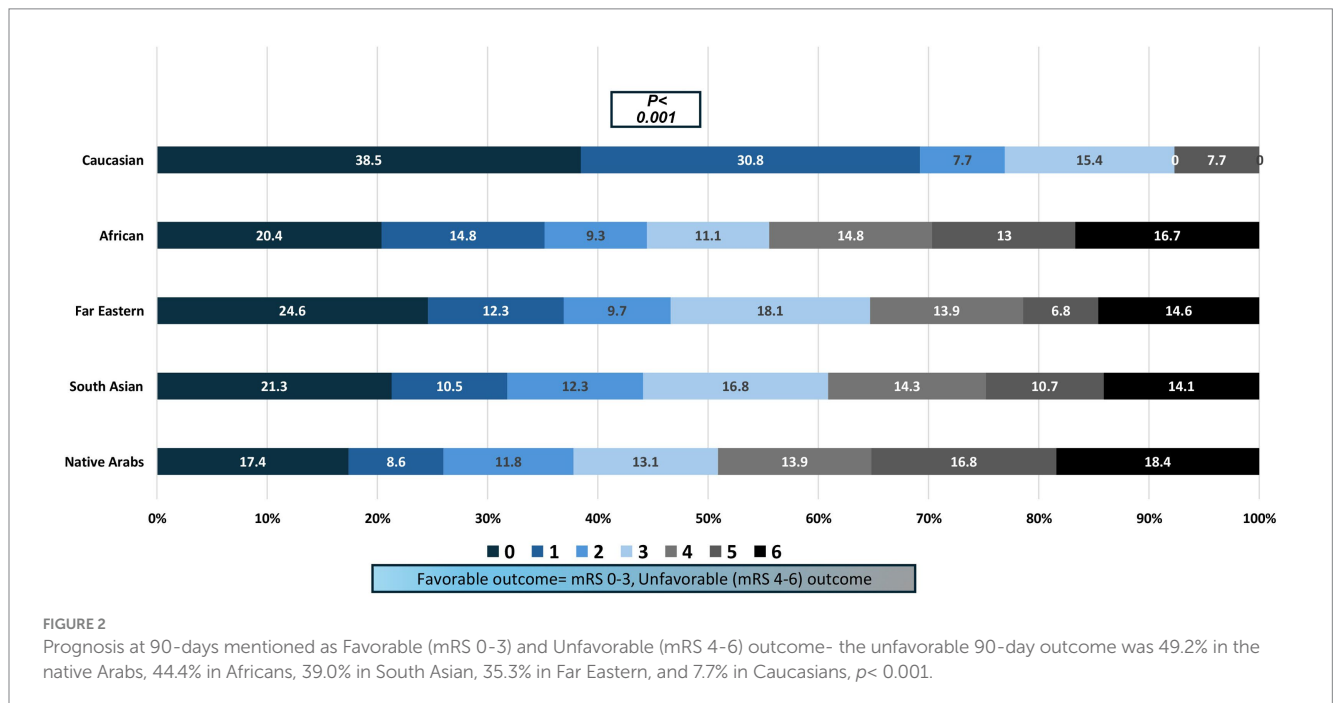
Variable	Favorable prognosis (n = 987, 59.5)	Unfavorable prognosis (n = 673, 40.5)	Total (n = 1,660)	p-value	
<b>Demographics</b>					
Median (IQR) age, years	48 (41–56)	50 (42–61)	49 (41.5–58)	<0.001	
Female, n (%)	149 (9)	132 (7.9)	281 (16.9)	0.016	
Male, n (%)	838 (50.5)	541 (32.6)	1,379 (83.1)		
<b>Expatriate</b>					
Native residents n (%)	190 (11.4)	184 (11.1)	374 (22.5)	<0.001	
South Asian n (%)	555(33.4)	355(21.4)	910 (54.8)		
Southeastern Asian n (%)	200 (12.1)	109 (6.6)	309 (18.6)		
African n (%)	30 (1.8)	24 (1.4)	54 (3.3)		
North American/European n (%)	12 (0.7)	1 (0.1)	13 (0.8)		
<b>Modes of arrival</b>					
Emergency medical system n (%)	797 (48)	587 (35.4)	1,384 (83.4)		<0.001
Interfacility transfer n (%)	53 (3.2)	44 (2.6)	97 (5.8)		
In-hospital stroke n (%)	6 (0.4)	5 (0.3)	11 (0.7)		
Private transport n (%)	131 (7.9)	37 (2.2)	168 (10.1)		
<b>Clinical assessments</b>					
Median systolic blood pressure mmHg	179 (154–204)	182 (152–210)	180 (153–206)	0.096	
Median diastolic blood pressure mmHg	105 (90–121)	106 (89–123)	105.5 (90–122)	0.827	
High blood pressure on admission n (%)	833 (50.2)	550 (33.1)	1,383 (83.3)	0.151	
Median baseline NIHSS	6 (2–12)	20 (13–25)	11 (4–20)	<0.001	
Median Glasgow coma scale	15 (14–15)	10 (6–14)	14 (10–15)	<0.001	
GCS Score 13–15	844 (50.8)	258 (15.5)	1,102 (66.4)	<0.001	
GCS Score 5–12	131 (7.9)	287 (17.3)	418 (25.2)		
GCS Score 3–4	12 (0.7)	128 (7.7)	140 (8.4)		
Median baseline blood glucose, mg%	7.2 (5.9–9.1)	8.3 (6.8–11)	7.5 (6.2–9.9)	<0.001	
Median BMI* Kg/m <sup>2</sup>	27 (24.2–30)	26.7 (24.2–29.7)	27 (24.2–29.9)	0.7	
<b>Medical comorbidities</b>					
Hypertension n (%)	630 (38)	425 (25.6)	1,055 (63.6)	0.280	
Diabetes n (%)	324 (19.5)	241 (14.5)	565 (34)	0.208	
Dyslipidemia n (%)	300 (18.1)	165 (9.9)	465 (28)	0.009	
Prior stroke n (%)	47 (2.8)	66 (4)	113 (6.8)	<0.001	
Atrial fibrillation n (%)	21 (1.3)	34 (2.1)	55 (3.3)	0.001	
Coronary artery disease n (%)	45 (2.7)	50 (3)	95 (5.7)	0.013	
Smoking n (%)	124 (7.5)	48 (2.9)	172 (10.4)	<0.001	
<b>Concomitant medications</b>					
Antihypertensive use n (%)	218 (13.1)	176 (10.6)	394 (23.7)	0.056	
Anticoagulants use n (%)	19 (1.1)	30 (1.8)	49 (2.9)	0.003	
Antiplatelet use n (%)	85 (5.1)	105 (6.3)	190 (11.4)	<0.001	
Antidiabetic use n (%)	99 (6)	91 (5.5)	190 (11.5)	0.028	
<b>Hemorrhage location</b>					
Supratentorial deep n (%)	654 (39.4)	429 (25.8)	1,083 (65.2)	<0.001	
Supratentorial cortical n (%)	174 (10.5)	95 (5.7)	269 (16.2)		
Infratentorial n (%)	127 (7.6)	139 (8.4)	266 (16)		
Primary intraventricular n (%)	32 (1.9)	10 (0.6)	42 (2.5)		

(Continued)

TABLE 1 (Continued)

Variable	Favorable prognosis (n = 987, 59.5)	Unfavorable prognosis (n = 673, 40.5)	Total (n = 1,660)	p-value
Any intraventricular n (%)	243 (14.6)	334 (20.1)	577 (34.8)	<0.001
Median intraparenchymal volume**, ml	5.2 (2.5–10.5)	13.2(5.8–24.4)	7.5 (3.2–15.8)	<0.001
Hemorrhage vol. ≥30 mL**	30 (2)	95 (6.3)	125 (8.3)	<0.001
ICH score 0**	524 (34.9)	125 (8.3)	649 (43.2)	<0.001
1	293 (19.5)	167 (11.1)	460 (30.7)	
2	63 (4.2)	161 (10.7)	224 (14.9)	
3	15 (1)	108 (7.2)	123 (8.2)	
4	2 (0.13)	39 (2.6)	41 (2.7)	
5	0 (0)	4 (0.3)	4 (0.3)	
Stroke unit care n (%)	595 (35.8)	131 (7.9)	726 (43.7)	<0.001
Intensive unit care n (%)	357 (21.5)	483 (29.1)	840 (50.6)	<0.001
Mechanical ventilation n (%)	132 (8)	432 (26)	564 (34)	<0.001
Extra-ventricular drainage n (%)	40 (2.4)	78 (4.7)	118 (7.1)	<0.001
Craniotomy/craniectomy n (%)	34 (2)	53 (3.2)	87 (5.2)	<0.001
Discharged home n (%)	507 (30.5)	44 (2.7)	551 (33.2)	<0.001
Admitted to rehabilitation n (%)	388 (23.4)	187 (11.3)	575 (34.6)	
Transferred to long-term care n (%)	17 (1)	141 (8.5)	158 (9.5)	
Hospitalization for other comorbidities n (%)	75 (4.5)	142 (8.6)	217 (13.1)	

\*BMI values available in 1508 patients; \*\*intraparenchymal volume, hemorrhage vol. ≥30 mL, ICH score is available in 1501.



### ICH localization and imaging characteristics

The most common location for the ICH was sub-cortical in the basal ganglia or the thalamus (1,072/1660; 64.6%). ICH location was

hemispheric in 280 (16.9%) patients, cerebellar in 152 (9.1%), brainstem in 114 (6.9%) patients, and primary intraventricular 42 (2.5%) patients. Most patients had small hemorrhages. The volume of the hemorrhage was less than 10 mL in patients 906 (60.4%) patients. The volume of the hematoma was between 10–19.9 mL in 311 (20.7%),

20–29.19 in 159 (10.6%) and more than 30 mL in 125 (8.3%) patients. The risk of early mortality and unfavorable outcome increased with increasing volume of the ICH. For each volume of the ICH, patients with infratentorial ICH were more likely to have a higher mortality at 30 and 90 days as shown in Figures 3A,B, 4. As is evident from Figure 4, the actual 30-day mortality in our patients was lower at all points of the ICH-score, when compared to the original publication (6). The younger age, smaller volume of ICHs and fewer infratemporal locations likely represent lower 30-day mortality in our study. There was a proportionate increase in unfavorable outcome with increasing ICH-score as shown in Figure 5.

### Antithrombotic medications and ICH prognosis

There were 49 (3%) patients on anticoagulation and 190 (11.4%) on antiplatelet medications at the time of the ICH

(Supplementary Tables S1, S2). These patients were older (61 (55–74) vs. 48 (41–56),  $p < 0.001$ ), and were more likely to have diabetes, CAD, atrial fibrillation and prior stroke. The severity of stroke as measured on the GCS and the NIHSS was not significantly different in patients with or without anticoagulants. ICH volume was also not significantly larger in patients on anticoagulation. Hemispheric location of the ICH was more common in patients taking anticoagulation (35.4% vs. 16.8%,  $p < 0.001$ ). Despite the similar volume, and as shown in Supplementary Table S1, the 30-day (22.4% vs. 10.1%;  $p = 0.005$ ) and 90-day (28.6% vs. 14.7%;  $p = 0.008$ ) mortality was higher in the anticoagulated patients. The percentage of patients with a favorable outcome (mRS 0–3) at 90-days was also lower in patients on anticoagulation (38.8% vs. 61.2%.  $p < 0.003$ ).

As shown in Supplementary Table S2, patients on antiplatelets were older ( $63.2 \pm 12.1$  vs.  $49.3 \pm 12.1$ ,  $p = 0.001$ ), and were more likely to have diabetes, CAD, atrial fibrillation and prior stroke. The severity of stroke was not significantly different in patients with or

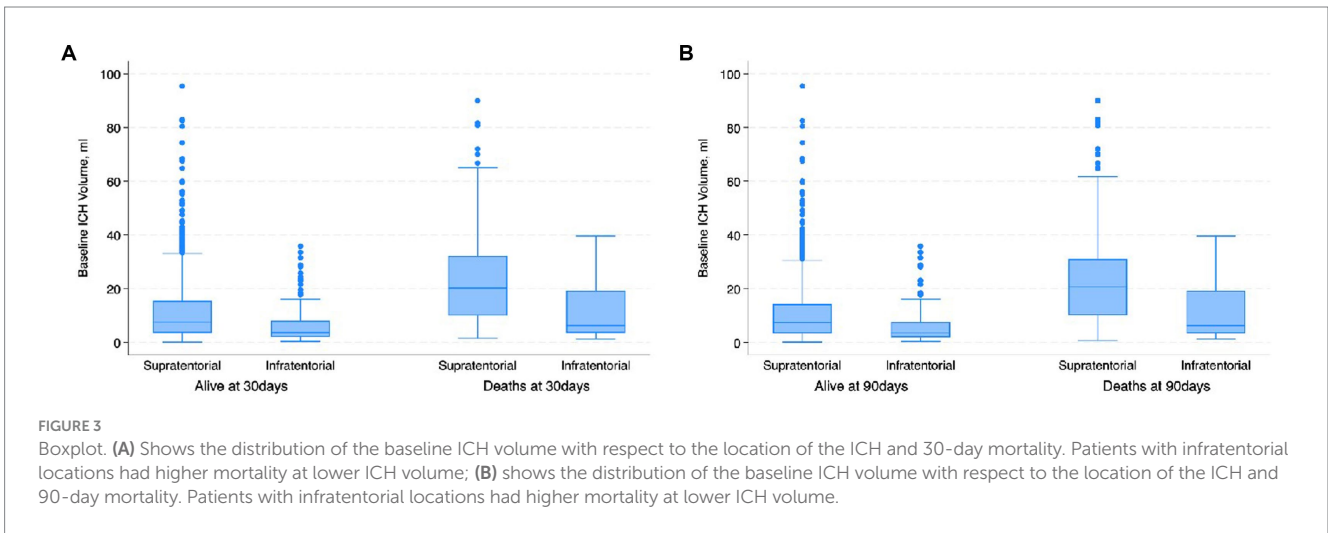


FIGURE 3 Boxplot. (A) Shows the distribution of the baseline ICH volume with respect to the location of the ICH and 30-day mortality. Patients with infratentorial locations had higher mortality at lower ICH volume; (B) shows the distribution of the baseline ICH volume with respect to the location of the ICH and 90-day mortality. Patients with infratentorial locations had higher mortality at lower ICH volume.

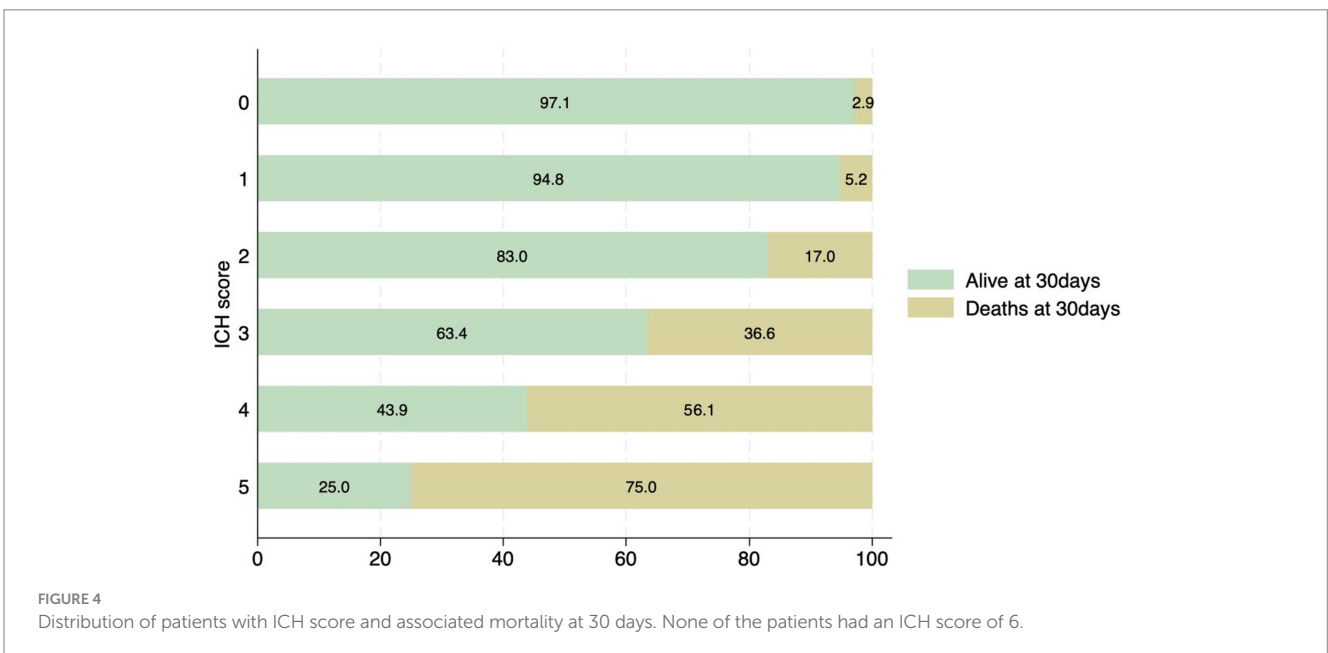


FIGURE 4 Distribution of patients with ICH score and associated mortality at 30 days. None of the patients had an ICH score of 6.



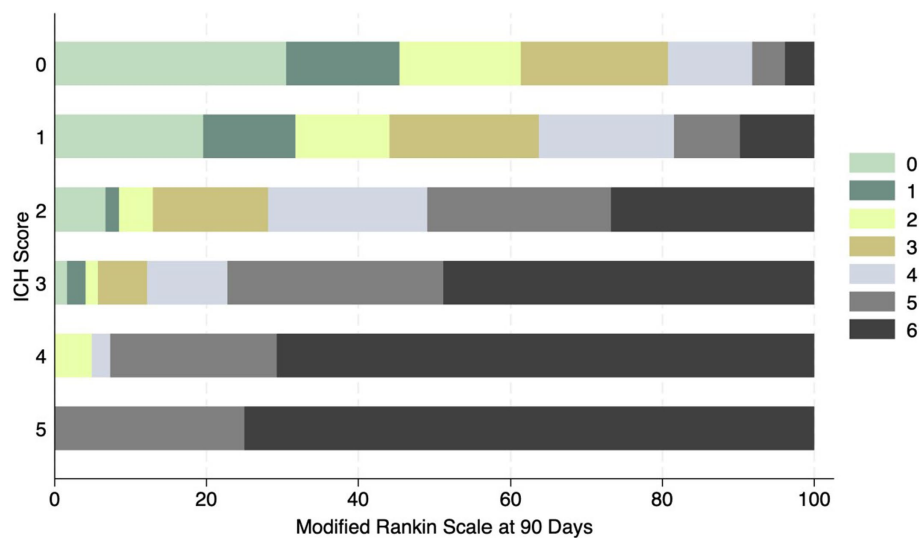


FIGURE 5  
Distribution of mRS at 90 days and ICH score in ICH patients. No patient had a score of 6.

without antiplatelets. ICH volume was also similar in patients on antiplatelets. Hemispheric location of the ICH was more common in patients taking antiplatelets (25.1% vs. 16.3%,  $p < 0.001$ ). Despite the similar volume of the ICH, and as shown in [Supplementary Table S2](#), the 30-day (14.7% vs. 9.9%;  $p = 0.04$ ) mortality was higher in patients with antiplatelets. The percentage of patients with a favorable outcome (mRS 0–3) at 90-days was also lower in patients on antiplatelet medications (44.7% vs. 55.3%,  $p < 0.001$ ).

## Diabetes and ICH prognosis

There were 564 (34%) patients with known diabetes at the time of the ICH. As [Supplementary Table S3](#), these patients were older ( $56.6 \pm 13.0$  vs.  $47.1 \pm 12.4$ ,  $p < 0.001$ ), and were more likely to have prior stroke history, CAD and atrial fibrillation. The severity of stroke was higher in patients with diabetes. A GCS of 13–15 was seen in 34.4% of patients with diabetes and 47.8% of patients without diabetes ( $p < 0.001$ ). Fewer patients with diabetes had an ICH volume  $< 10$  mL ( $56.4$  vs.  $60.6$ ,  $p < 0.001$ ) and hemispheric location of the ICH was more common in patients with diabetes (19.8% vs. 16.6%,  $p = 0.02$ ). The 30-day (13.2% vs. 8.8%;  $p < 0.001$ ) and 90-day mortality (18.8% vs. 13.6%;  $p < 0.001$ ) was significantly higher in the diabetic patients.

The multivariable analysis for the 30-day, 90-day mortality and 90-days unfavorable outcome are shown in [Table 2](#). Baseline lower GCS, baseline ICH volume, and infratentorial location, presence of any intraventricular hemorrhage, no surgical intervention was all associated with a higher risk of 30-day and 90-day mortality and higher 90-day unfavorable outcome. The receiver operator curve analysis showed lower GCS score had the highest area-under the curve 0.80, 0.81 and 0.79 among all the variables to predict 30-day, 90-day mortality and 90-day unfavorable outcome ([Table 2](#)). Baseline ICH volume showed

moderate concordance with AUC of 0.69, 0.71 and 0.71 to predict 30-day, 90-day mortality and 90-day unfavorable outcome. Other variables were fair.

## Discussion

Intracerebral hemorrhage comprised 14.8% of consecutive stroke patients admitted with acute stroke in Qatar. The patients were young, had male predominance and from multiple ethnicities, reflecting the population dynamics in Qatar where ~85% of the population is expatriate and mostly comprised of young male workers ([28–32](#)). The mortality at 30 days (10.4%) and 90 days (15.1%) was lower in our patients when compared to the previous reports of 30–55% in the literature ([2–5](#)). Smaller volume of the hematoma in most of our subjects [only 125 (8.3%) of patients with ICH of  $\geq 30.0$  mL/cm<sup>3</sup>], and smaller number of patients with low GCS of 3–4 [140 (8.4%)] likely contributed to the lower mortality. We are not sure of the reasons of the smaller size of the ICH in this population. Perhaps the younger age, especially in the patients from South East and Far East Asia may have been a factor for the smaller hemorrhages. We also noted a significantly lower mortality in our patients. It is possible that admission to a stroke unit or ICU in a majority of patients may have also contributed to the lower mortality. Maximally treated ICH patients have been shown to have lower mortality in a previous study ([11](#)). Increasing age, presence of vascular risk factors, especially diabetes, and the use of antithrombotic medications, especially anticoagulants, were most likely to associated with an unfavorable outcome.

Most studies on ICH focus on mortality, especially early deaths in the hospital and within the initial 30 days. Patients who survive the initial insult are however left with significant disability. The mRS is used globally to determine recovery following ischemic stroke and has been used in occasional ICH studies to evaluate recovery at 90 days to a year ([21, 23, 33–35](#)). An mRS of 0–3

TABLE 2 Multivariable association of predictors with 30- and 90-day mortality.

Factor	30 days mortality			90 days mortality		
	uOR (95% CI)	aOR (95% CI)	AUC	uOR (95% CI)	aOR (95% CI)	AUC
Age, years	1.00 (0.99–1.01)	1.00 (0.99–1.02)	0.51	1.01 (0.99–1.02)	0.99 (0.98–1.02)	0.52
Sex	0.78 (0.53–1.16)	0.92 (0.58–1.46)	0.48	0.81 (0.58–1.14)	0.76 (0.45–1.26)	0.49
Expatriate South Asian/southeastern Asian status	0.88 (0.62–1.24)	1.16 (0.74–1.81)	0.52	0.77 (0.57–1.03)	0.94 (0.56–1.58)	0.52
GCS score	0.76 (0.73–0.79)	0.78 (0.75–0.82)	0.80	0.74 (0.72–0.77)	0.79 (0.75–0.83)	0.81
Baseline blood glucose, mg%	1.08 (1.04–1.12)	1.02 (0.98–1.06)	0.62	1.08 (1.05–1.11)	1.02 (0.97–1.07)	0.64
Use of antiplatelet medication	1.58 (1.02–2.44)	1.56 (0.92–2.63)	0.53	1.42 (0.96–2.09)	2.02 (1.13–3.59)	0.52
ICH volume, ml	1.04 (1.03–1.05)	1.02 (1.01–1.03)	0.69	1.05 (1.04–1.06)	1.02 (1.01–1.03)	0.71
Infratentorial location	2.82 (1.98–4.01)	1.90 (1.19–3.02)	0.57	2.72 (1.99–3.71)	2.40 (1.46–3.94)	0.56
Any intraventricular	2.98 (2.16–4.11)	1.46 (1.02–2.09)	0.64	2.97 (2.26–3.91)	1.57 (1.04–2.35)	0.64
Admission to intensive care unit	3.00 (2.11–4.26)	1.25 (0.82–1.91)	0.63	3.92 (2.87–5.35)	0.82 (0.51–1.33)	0.66
Any surgical intervention	0.86 (0.26–2.83)	0.27 (0.14–0.54)	0.49	0.77 (0.27–2.21)	0.26 (0.15–0.45)	0.50

usOR, unadjusted odds ratio; aOR, adjusted odds ratio.

(favorable outcome) at 90 days following the ICH was evident in 59.5% of patients in our study. In a smaller study of 243 patients, only 51% of patients reached an mRS of 0–2 at 3 months follow-up and 56% by one-year follow-up (34). The larger study with 3,255 patients from China also showed an mRS of 0–2% in 49% of patients at 90-days and 53% by one year (23). In the Swiss Stroke Registry, 2,650 patients with ICH were followed for functional recovery and 33.2% showed good functional recovery (mRS 0–2) at 3 months (35). In a study of 919 patients from the CLEAR-III and MISTIE-III trials, 11.5% died within 30 days and an mRS of 0–3 was seen in only 14.7% at 30 days (36). Finally, in the recent study from Montreal, similar to our study, favorable outcome (an mRS of 0–3 at 3 months) was evident in 50 percent of patients (33, 37). The mRS at 90-days may therefore be an important measure of recovery in addition to the mortality at 30-days following an ICH to determine prognosis.

There are some limitations to our research. Although the patients were all entered into the database prospectively, this is a retrospective analysis of the registry. Secondly, the analysis is from a single center in one country. The comparison of clinical and outcome data in a large number of patients from multiple ethnicities is, we believe, a major strength of the study. Thirdly, our follow-up is limited to the 90-day outcome as part of the registry data collection. As shown in the study by Hemphill from USA (6) and Wang et al. from China (23), recovery continues well beyond the initial 90 days, we do not have long-term outcome information from our research.

In summary, our study outlines the clinical and radiological features of ICH in a large multiethnic cohort of patients from a single center in Qatar. Our patients were younger and the hematomas were most frequently seen in the sub-cortical thalamic and basal ganglion region. The 30-day mortality was significantly better than what has been previously reported. The lower mortality may be related to the younger age at presentation, fewer patients with sub-tentorial hemorrhages and the small volume of the hematomas. Despite the lower mortality at 30 days, favorable outcome was evident in only 44.5% patients at 90 days.

## Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

## Ethics statement

The studies involving humans were approved by the Institutional Review Board of the Medical Research Centre at Hamad Medical Corporation (MRC-01-18-102). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## Author contributions

NA: Writing – original draft, Writing – review & editing. MK: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. SK: Methodology, Writing – review & editing. SJ: Data curation, Writing – review & editing. DM: Data curation, Methodology, Writing – review & editing. RU: Data curation, Writing – review & editing. BB: Data curation, Methodology, Writing – review & editing. SS: Data curation, Methodology, Writing – review & editing. AS: Conceptualization, Methodology, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fneur.2024.1384985/full#supplementary-material>

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