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Orapuh Journal

ORIGINAL ARTICLE

Journal of Oral & Public Health

Prognostic Factors and Discriminative Performance of the ICH Score in Intensive Care Units: A Multicenter Study in Kinshasa

Ebondo, I.[1], Mbuyi, F.[1,2], Ilunga, J.-P.[1], Kandongo, D.[1], Kwama, H.[1,3], Kam, E.[4], Ngoyi, P.[1], Mukuna, P.[1], Buti, O.[1,4], Ngoy, H.[5], Mbombo, W.[1], Bula Bula, M.[1], Nsiala, J.[1], & Barhayiga, B.[1]

[1]*Department of Anesthesia and Intensive Care, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, Democratic Republic of the Congo* [2]*Anesthesia and Intensive Care Unit, Ngaliema Medical Center, Kinshasa, Democratic Republic of the Congo* [3]*Department of Physical Medicine and Rehabilitation, University Clinics of Kinshasa, Adult Neurorehabilitation Unit, University of Kinshasa, Kinshasa, Democratic Republic of the Congo* [4]*Anesthesia and Intensive Care Unit, HJ Hospitals, Kinshasa, Democratic Republic of the Congo* [5]*Anesthesia and Intensive Care Unit, Military Hospital of the Republican Guard, Camp Colonel Tshiatshi, Kinshasa, Democratic Republic of the Congo*

ARTICLE INFO

Received: *26 June 2026*
Accepted: *26 August 2026*
Published: *11 November 2026*

Keywords:
Spontaneous intracerebral hemorrhage, mortality, prognostic factors, ICH score, survival, intensive care

Peer-Review: *Externally peer-reviewed*

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Correspondence to:
Dr. Ivan Ebondo
ivanebondo@gmail.com

To cite:
Ebondo, I., Mbuyi, F., Ilunga, J.-P., Kandongo, D., Kwama, H., Kam, E., Ngoyi, P., Mukuna, P., Buti, O., Ngoy, H., Mbombo, W., Bula Bula, M., Nsiala, J., & Barhayiga, B. (2026). Prognostic factors and discriminative performance of the ICH score in intensive care units: A multicenter study in Kinshasa. *Orapuh Journal, 7*(10), e1495.
https://doi.org/10.4314/orapj.v7i10.95

ISSN: *2644-3740*

Published by ***Orapuh, Inc.***, F. Gaye Res., Sukuta-Jamisa, Greater Banjul, The Gambia.

Editor-in-Chief: *Prof. V. E. Adamu (editor@orapuh.org)*

ABSTRACT

Introduction

Spontaneous intracerebral hemorrhage (sICH) is associated with high mortality, particularly in resource-limited settings. The performance of the Intracerebral Hemorrhage (ICH) score remains insufficiently documented in sub-Saharan Africa.

Purpose

This study aimed to identify factors associated with mortality and evaluate the discriminative performance of the ICH score in intensive care units in Kinshasa.

Methods

A multicenter observational cohort study was conducted in 58 patients with computed tomography (CT)-confirmed sICH. Mortality predictors were assessed using Cox proportional hazards regression and Firth penalized logistic regression. Survival was analyzed using Kaplan–Meier methods, and the discriminative performance of the ICH score was evaluated using receiver operating characteristic (ROC) curve analysis.

Results

The mean age was 56.7±12.3 years, and 60.3% of patients were female. Overall mortality was 65.5%. Mechanical ventilation was independently associated with mortality (adjusted hazard ratio [aHR] = 24.43; 95% confidence interval [CI]: 2.92–204.57; p=0.003). In the Firth penalized logistic regression model, an ICH score ≥3 was not independently associated with 30-day mortality (odds ratio [OR] = 3.00; 95% CI: 0.66–13.69; p=0.156). Median survival was shorter among patients with an ICH score ≥3 than among those with an ICH score <3 (5 vs. 8 days; log-rank p=0.009). The ICH score showed moderate discriminative ability (area under the curve [AUC] = 0.714). At a threshold of ≥3, sensitivity was 57.9%, specificity 85.0%, positive predictive value (PPV) 88.0%, and negative predictive value (NPV) 53.1%.

Conclusion

Mortality was high among patients with sICH admitted to intensive care units in Kinshasa. Mechanical ventilation was independently associated with mortality and should be interpreted primarily as a marker of severe illness. The ICH score demonstrated moderate discriminative ability, with relatively high specificity but limited sensitivity at a threshold of ≥3. It may support early risk stratification but should complement, rather than replace, comprehensive clinical assessment.

INTRODUCTION

Spontaneous intracerebral hemorrhage (sICH) is one of the most severe forms of stroke, accounting for approximately 10%–20% of all strokes worldwide. It results from the spontaneous rupture of an intracerebral vessel, leading to blood accumulation within the brain parenchyma and triggering a cascade of primary and secondary injuries responsible for rapid neurological deterioration (Greenberg et al., 2022). Despite advances in neuroimaging, neurosurgery, and neurocritical care, sICH remains associated with high morbidity and mortality, with nearly 40% of patients dying within 30 days and fewer than one-third regaining functional independence in the long term (van Asch et al., 2010; Greenberg et al., 2022).

According to the Global Burden of Disease Study, intracerebral hemorrhage (ICH) disproportionately contributes to the global stroke burden due to its high lethality, severe functional disability, and substantial healthcare costs. Globally, the incidence of sICH is estimated at 20–30 cases per 100,000 population per year, with a marked increase in low-resource countries, where cardiovascular risk factor control remains inadequate.

According to the Global Burden of Disease Study, intracerebral hemorrhage (ICH) disproportionately contributes to the global stroke burden due to its high lethality, severe functional disability, and substantial healthcare costs (Feigin et al., 2025). Globally, the incidence of sICH is estimated at 20–30 cases per 100,000 population per year, with a marked increase in low-resource countries, where cardiovascular risk factor control remains inadequate (Feigin et al., 2025; Owolabi et al., 2021).

Chronic hypertension remains the leading risk factor for sICH, accounting for more than half of cases. Other risk factors include smoking, chronic alcohol consumption, diabetes mellitus, antithrombotic therapy, advanced age, and cerebral amyloid angiopathy (Akinyemi et al., 2021; Sarfo & Ovbiagele, 2024), all of which influence disease occurrence and clinical outcomes.

The burden of sICH is particularly alarming in sub-Saharan Africa, where stroke-related mortality and disability are rapidly increasing (Owolabi et al., 2021). In the Democratic Republic of the Congo, data on prognostic factors remain scarce despite the growing burden of cardiovascular diseases. Early identification of patients at high risk of death is therefore essential to optimize management, improve prognostic stratification, and rationalize the use of limited intensive care resources (Hwang et al., 2024). In this context, several scoring systems have been developed, including the Intracerebral Hemorrhage (ICH) score proposed by Hemphill et al., which remains the most widely used clinical tool (Hemphill et al., 2001). It incorporates five easily obtainable admission variables: age, hematoma volume, Glasgow Coma Scale (GCS) score, infratentorial location, and intraventricular extension. Several studies have demonstrated its predictive value for early mortality and functional outcome in patients with ICH (Gregório et al., 2018; Alkhachroum et al., 2023).

However, variations in the prognostic performance of the ICH score have been reported depending on study populations, patient characteristics, and healthcare system resources (Alkhachroum et al., 2023; Parry-Jones et al., 2024). In sub-Saharan Africa, particularly in Central Africa, evidence regarding its validity remains limited. Evaluating this tool in low-resource settings is therefore essential to determine its clinical relevance and local applicability.

This multicenter study aimed to identify prognostic factors associated with mortality and to evaluate the discriminative performance of the ICH score in patients with spontaneous intracerebral hemorrhage admitted to intensive care units in Kinshasa.

METHODS

Study Design and Setting

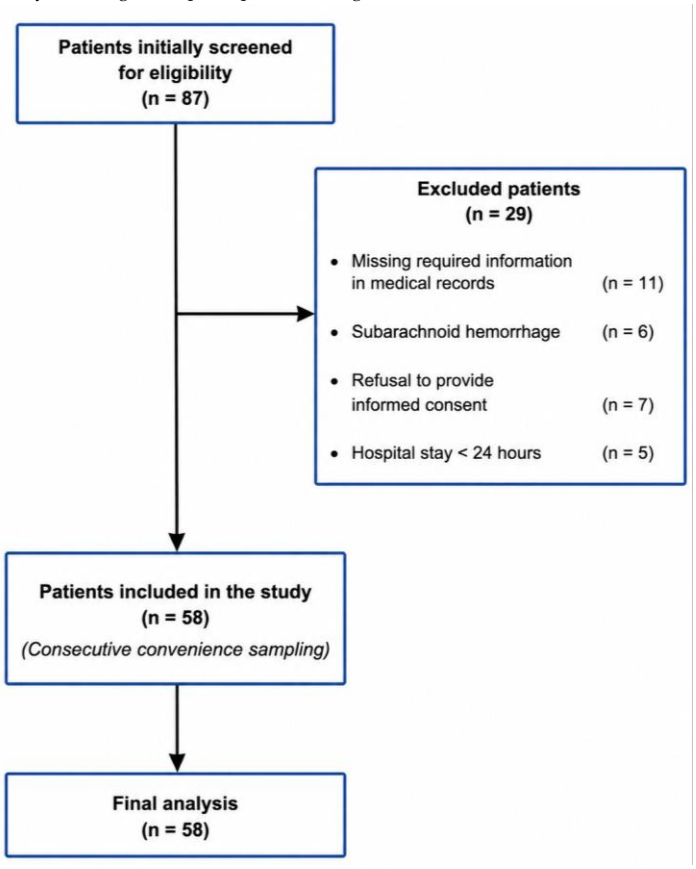
We conducted a prospective multicenter observational cohort study involving patients with spontaneous intracerebral hemorrhage (sICH) admitted to the anesthesiology and intensive care departments of eight healthcare institutions in Kinshasa, Democratic Republic of the Congo (DRC). The study was conducted between April 1 and September 30, 2025.

The study was carried out in accordance with the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (World Medical Association, 2013).

Participants

A total of 87 patients were initially screened for eligibility. Of these, 58 patients were included using a consecutive convenience sampling approach based on predefined inclusion criteria. Twenty-nine patients were excluded because they did not meet the eligibility criteria, including 11 patients with missing required information in their medical records, 6 with subarachnoid hemorrhage, 7 who declined to provide informed consent, and 5 who had been hospitalized for less than 24 hours **(Figure 1)**.

Figure 1:
Study flow diagram of participant screening and selection.



The 58 included patients were aged ≥18 years, admitted to the intensive care unit for CT-confirmed spontaneous intracerebral hemorrhage, and hospitalized for at least 24 hours. In addition, eligible patients were required to have complete medical records containing the variables of interest and to provide informed consent either personally or through a family representative.

Patients with secondary intracerebral hemorrhage (traumatic brain injury, cerebral vascular malformation, intracranial tumor, ruptured aneurysm, or other causes), those without brain computed tomography, patients with incomplete medical records, individuals younger than 18 years of age, those hospitalized for less than 24 hours, and those who did not provide consent were excluded.

No formal sample size calculation was performed before study initiation. The sample size was pragmatically determined according to the number of eligible patients available during the recruitment period across the participating healthcare institutions.

Study Variables

Sociodemographic Variables

The following sociodemographic characteristics were collected:

- Age (years);
- Sex.

Clinical and Therapeutic Variables

The clinical variables collected at admission included:

- Medical history of hypertension, chronic kidney disease, diabetes mellitus, smoking, alcohol consumption, and previous stroke;
- Admission systolic blood pressure, particularly ≥180 mmHg;
- Glasgow Coma Scale (GCS) score (≤8/15);
- Pupillary abnormalities;
- Presence of seizures;
- Respiratory distress;
- Intracranial hypertension;
- ICH score ≥3;
- Requirement for mechanical ventilation;
- Vital status.

Neuroimaging Variables

The radiological variables assessed by brain computed tomography included:

- Hematoma volume >30 mL;
- Intraventricular extension.

Hematoma volume was estimated using the standard ABC/2 (Tada ellipsoid) method:

$V = 2A \times B \times C$

where A represents the largest hematoma diameter, B the diameter perpendicular to A, and C the number of CT slices on which the hematoma was visible multiplied by the slice thickness.

A hematoma volume exceeding 30 mL was considered clinically significant in accordance with international recommendations.

Calculation of the ICH Score

The ICH score was calculated according to the method proposed by Hemphill et al.. It ranges from 0 to 6 points and is based on five clinicoradiological parameters: Glasgow Coma Scale score, age, hematoma volume, intraventricular extension, and infratentorial location.

Consistent with previous validation studies, an ICH score ≥3 was considered indicative of a high risk of mortality (Gregório et al., 2018; Hwang et al., 2024).

Outcomes

Primary Outcome

The primary outcome was all-cause in-hospital mortality.

Secondary Outcomes

Secondary outcomes included:

- Length of survival during hospitalization;
- Thirty-day mortality;
- Prognostic performance of the ICH score.

Ethical Considerations

The study protocol was approved by the Ethics Committee of the School of Public Health of the University of Kinshasa (Approval No. ESP/CE/126/2025).

The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations. All data were analyzed anonymously to ensure the confidentiality of medical information.

Statistical Analysis

Statistical analyses were performed using Jamovi version 2.6.44. The normality of continuous variables was assessed using the Shapiro–Wilk test. Continuous variables were presented as mean ± standard deviation or median (interquartile range), according to their distribution, whereas categorical variables were expressed as frequencies and percentages.

Factors associated with mortality were first investigated using univariable Cox proportional hazards regression. Variables with statistically significant associations were subsequently entered into a multivariable Cox regression model. Results were reported as adjusted hazard ratios (aHRs) with their corresponding 95% confidence intervals (95% CIs).

Because of the small number of mortality events and the risk of small-sample bias and separation, a Firth penalized logistic regression model was used to identify factors independently associated with 30-day mortality. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported.

Survival was assessed using the Kaplan–Meier method, with survival curves compared using the log-rank test according to ICH score (<3 vs. ≥3), Glasgow Coma Scale (GCS) score (>8 vs. ≤8), and hematoma volume (≤30 mL vs. >30 mL). Cox proportional hazards regression was subsequently performed to identify factors associated with mortality. Hazard ratios (HRs) with 95% confidence intervals (CIs) were reported. The proportional hazards assumption was assessed using Schoenfeld residuals.

The discriminative performance of the ICH score for mortality was evaluated using receiver operating characteristic (ROC) curve analysis, with calculation of the area under the curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). A two-sided p-value <0.05 was considered statistically significant.

RESULTS

General Characteristics of the Study Cohort

A total of 58 patients with intracerebral hemorrhage admitted to the intensive care unit were included in the study. The mean age of the patients was 56.7±12.3 years,

with a female predominance (60.3%) and a male-to-female ratio of 0.64 **(Table 1)**.

Table 1:
Sociodemographic and Clinical Characteristics of the Study Cohort

Variable	*n* (%) or Mean ± SD
Age (years)	56.7±12.3
Male	23 (39.7)
Female	35 (60.3)
Hypertension (HTN)	50 (86.2)
Systolic BP >180 mmHg at admission	24 (41.4)
Diabetes mellitus	6 (10.3)
Nephropathy	1 (1.7)
Smoking	6 (10.3)
Alcohol consumption	32 (55.2)
History of stroke recurrence	10 (17.2)
Altered consciousness	48 (82.8)
GCS ≤8	20 (34.5)
Seizures	5 (8.6)
Respiratory distress	3 (5.2)
Functional disability	7 (12.1)
Dysarthria	3 (5.2)
ICH score ≥3	25 (43.1)
Intracranial hypertension	40 (69.0)
Normal pupils	24 (41.4)
Mydriasis	11 (19.0)
Bilateral miosis	14 (24.1)
Anisocoria	9 (15.5)
Death outcome	38 (65.5)
Survival outcome	20 (34.5)

Hypertension, alcohol consumption, and diabetes mellitus were identified as past medical histories in 86.2%, 55.2%, and 10.3% of patients, respectively **(Table 1)**.

At admission, 41.4% of patients presented with a systolic blood pressure >180 mmHg. Impaired consciousness was observed in 82.8% of patients, while 34.5% had a Glasgow Coma Scale (GCS) score ≤8 **(Table 1)**.

An ICH score ≥3 was found in 43.1% of patients, and 69.0% developed intracranial hypertension. The overall mortality rate was 65.5% **(Table 1)**.

Factors Associated with Mortality

Univariate Analysis

Several factors were associated with mortality in the univariable Cox analysis. Hematoma volume >30 mL was associated with an increased hazard of death (HR = 2.21; 95% CI: 1.10–4.42; p=0.025). Similarly, an ICH score ≥3 was associated with increased mortality (HR = 2.19; 95% CI: 1.15–4.17; p=0.018). Mechanical ventilation showed a strong association with mortality (HR = 19.06; 95% CI: 2.61–139.10; p=0.004), as did intracranial hypertension (HR = 3.09; 95% CI: 1.20–7.92; p=0.019). A GCS score ≤8 showed a borderline association with mortality (HR = 1.85; 95% CI: 0.97–3.53; p=0.063), whereas intraventricular extension and systolic blood pressure >180 mmHg were not significantly associated with mortality **(Table 2)**.

Table 2:
Univariable Cox Regression Analysis of Factors Associated with Mortality

Variable	Crude HR	95% CI	*p*-value
Age >65 years	0.78	0.34–1.78	0.556
GCS ≤8	1.85	0.97–3.53	0.063
Hematoma volume >30 mL	2.21	1.10–4.42	0.025
Intraventricular extension	1.07	0.57–2.04	0.829
ICH score ≥3	2.19	1.15–4.17	0.018
Mechanical ventilation	19.06	2.61–139.10	0.004
Systolic blood pressure >180 mmHg	1.67	0.88–3.17	0.120
Intracranial hypertension	3.09	1.20–7.92	0.019

Multivariable Analysis (Cox Model)

After adjustment, mechanical ventilation remained independently associated with mortality (aHR = 24.43; 95% CI: 2.92–204.57; p=0.003). Neither ICH score ≥3 (aHR = 1.27; 95% CI: 0.62–2.61; p=0.514) nor intracranial hypertension (aHR = 0.59; 95% CI: 0.20–1.80; p=0.355) was independently associated with mortality in the reduced Cox model **(Table 3)**.

Table 3:
Multivariate Cox Regression Analysis of Factors Associated with Mortality

Variable	aHR	95% CI	*p*-value
ICH score ≥3	1.27	0.62–2.61	0.514
Mechanical ventilation	24.43	2.92–204.57	0.003
Intracranial hypertension	0.59	0.20–1.80	0.355

Firth Penalized Logistic Regression Analysis of 30-Day Mortality

In the Firth penalized logistic regression analysis, mechanical ventilation was independently associated with 30-day mortality (OR = 99.12; 95% CI: 4.76–2064.41; p=0.003). An ICH score ≥3 was associated with higher odds of 30-day mortality (OR = 3.00; 95% CI: 0.66–13.69), but this association did not reach statistical significance (p=0.156). Intracranial hypertension was not significantly associated with 30-day mortality (OR = 0.37; 95% CI: 0.015–9.29; p=0.546). The very wide confidence intervals indicate substantial uncertainty in the estimates, reflecting the small sample size and limited number of events. Therefore, these multivariable estimates should be interpreted cautiously **(Table 4)**.

Table 4:
Firth Penalized Logistic Regression Analysis of Factors Associated with 30-Day Mortality

Variable	OR (Firth)	95% CI	*p*-value
ICH score ≥3	3.00	0.66–13.69	0.156
Mechanical ventilation	99.12	4.76–2064.41	0.003
Intracranial hypertension	0.37	0.015–9.29	0.546

Note: Firth penalized logistic regression was used to reduce small-sample bias and potential separation. OR, odds ratio; CI, confidence interval.

Survival Analysis

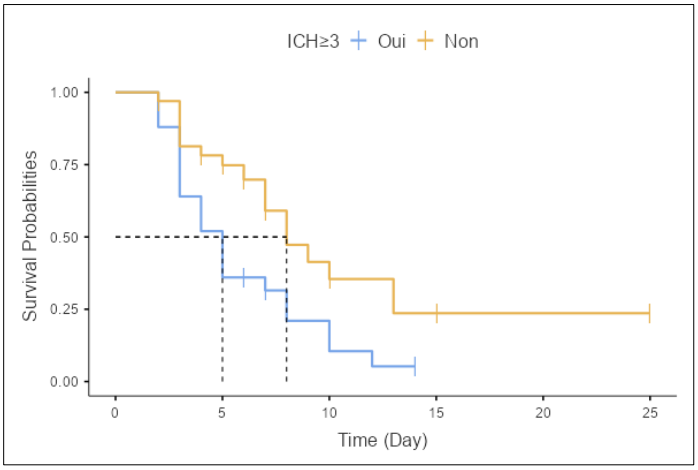
In the survival analysis, patients with an ICH score ≥3 had a shorter median survival than those with an ICH score <3 (5 days vs. 8 days; log-rank p=0.009). Similar findings were observed among patients with a GCS score ≤8 (3.5 days vs. 8 days; log-rank p=0.043) and those with a hematoma volume >30 mL (5 days vs. 10 days; log-rank p=0.014) **(Table 5)**.

Table 5:
Median Survival According to Prognostic Factors

Variables	Median Survival (Days)	Log-Rank *p*-value
ICH score <3	8.0	0.009
ICH score ≥3	5.0	
GCS score >8	8.0	0.043
GCS score ≤8	3.5	
Hematoma volume ≤30 mL	10.0	0.014
Hematoma volume >30 mL	5.0	

Furthermore, the Kaplan–Meier survival curves demonstrated a significant reduction in survival among patients with higher ICH scores **(Figure 2)**.

Figure 2:
Kaplan–Meier survival curves according to the ICH score



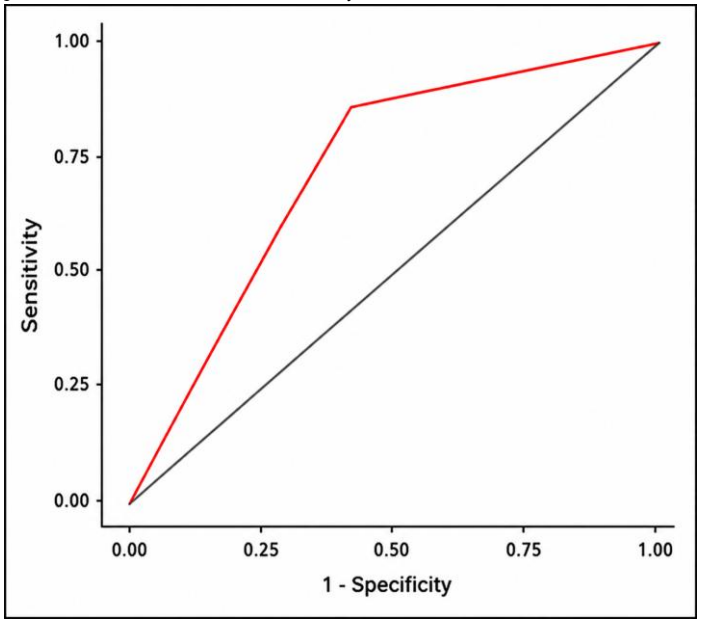
Discriminative Performance of the ICH Score

The ICH score demonstrated moderate discriminative ability for mortality. The area under the receiver operating characteristic (ROC) curve was 0.714, indicating a moderate discriminative ability of the score **(Table 6, Figure 3)**. Using a threshold of ICH score ≥3, the score showed a sensitivity of 57.9% and a specificity of 85.0%, with a PPV of 88.0% and an NPV of 53.1%. The unadjusted odds of mortality were higher among patients with an ICH score ≥3 (OR = 7.79; 95% CI: 1.95–31.16; p=0.004) **(Table 6)**.

Table 6:
Discriminative Performance of the ICH Score for Mortality

Parameter	Value
AUC (ROC)	0.714
Sensitivity (%)	57.9
Specificity (%)	85.0
Positive Predictive Value (PPV) (%)	88.0
Negative Predictive Value (NPV) (%)	53.1
Unadjusted OR	7.79
95% CI of OR	1.95–31.16
p-value	0.004
Cut-off used	ICH score ≥3

Figure 3:
Receiver operating characteristic (ROC) curve showing the discriminative performance of the ICH score for mortality



DISCUSSION

The present multicenter study conducted in Kinshasa aimed to identify factors associated with mortality in patients with intracerebral hemorrhage (ICH) and to evaluate the discriminative performance of the ICH score in intensive care. The main findings demonstrated a high mortality rate (65.5%), a statistically significant association between initial clinical severity and vital outcome, and an

acceptable discriminative performance of the ICH score in predicting mortality based on ROC analysis.

High Mortality and Epidemiological Context

The high mortality observed in this study is consistent with international data, which report 30-day mortality rates ranging from 35% to 60%, depending on the studied populations and levels of care (Greenberg et al., 2022; Hwang et al., 2024). In low-resource settings, mortality is generally higher due to delayed diagnosis, limited access to specialized neurocritical care, and the lack of standardized intensive management protocols (Witsch et al., 2021).

In a recent meta-analysis, ICH was confirmed as the most lethal form of stroke, associated with mortality rates reaching up to 40% at one month and significant functional dependence among most survivors (Zhu et al., 2024). These findings highlight the substantial burden of this condition on intensive care units and health services.

Clinical and Prognostic Factors

In our cohort, a GCS score ≤8 was associated with a higher hazard of mortality in the expected direction, although this association did not reach statistical significance in the univariable Cox analysis (HR = 1.85, 95% CI: 0.97–3.53, p=0.063). This finding is nevertheless consistent with the established prognostic relevance of impaired consciousness in patients with intracerebral hemorrhage, as lower admission GCS scores have been associated with increased mortality and poor functional outcomes (Hwang et al., 2024; Witsch et al., 2021; Zhu et al., 2024).

The association between intracranial hypertension and mortality is also biologically plausible, as increased intracranial pressure generally reflects hematoma expansion, significant perihematomal edema, or failure of intracranial compensatory mechanisms. These processes lead to reduced cerebral perfusion pressure, secondary ischemia, and brain herniation, which are major causes of death in severe ICH (Hwang et al., 2024; Witsch et al., 2021). Recent neurocritical care studies have also confirmed the role of intracranial hypertension in increased in-hospital mortality and poor neurological outcomes (Greenberg et al., 2022).

Furthermore, hematoma volume and the ICH score were significantly associated with survival in univariate and Kaplan–Meier analyses. These findings are consistent with the known pathophysiological mechanisms of intracerebral hemorrhage. A large hematoma increases intracranial mass effect and is frequently associated with intraventricular extension, thereby exacerbating secondary brain injury, leading to rapid neurological deterioration (Zhu et al., 2024; Parry-Jones et al., 2024). In our series, patients with hematoma volumes greater than 30 mL had significantly shorter median survival, consistent with multiple international cohorts identifying hematoma volume as a major determinant of early mortality (Zhu et al., 2024; Parry-Jones et al., 2024).

In the present study, an ICH score ≥3 was significantly associated with mortality in univariable analysis and was associated with shorter survival. However, in the Firth penalized logistic regression model for 30-day mortality, this association was no longer statistically significant (OR = 3.00; 95% CI: 0.66–13.69; p=0.156). This discrepancy highlights the uncertainty of multivariable estimates in a small cohort with a limited number of events and suggests that, in this sample, the ICH score is best interpreted as a prognostic stratification tool rather than as an independently established predictor of 30-day mortality. Nevertheless, previous validation studies support the use of the ICH score as a simple and reproducible tool for early risk stratification in patients with intracerebral hemorrhage across different clinical settings (Gregório et al., 2018; Alkhachroum et al., 2023).

Multivariate Analysis and Interpretation

In the multivariable Cox model, mechanical ventilation was the only factor that remained statistically associated with mortality (aHR = 24.43; 95% CI: 2.92–204.57; p=0.003). This association should not be interpreted as evidence that mechanical ventilation itself causes mortality. Rather, the need for mechanical ventilation is likely to reflect underlying disease severity, including severe neurological impairment, loss of airway protective reflexes, respiratory compromise, or rapidly deteriorating neurological status. Mechanical ventilation should therefore be considered primarily as a marker of disease severity in this observational cohort, with potential indication bias limiting causal interpretation (Greenberg et al., 2022; Hwang et al., 2024). The very wide confidence interval indicates substantial uncertainty regarding the magnitude of this

association, which may be related to the relatively small sample size and limited number of mortality events. Previous studies have similarly shown that the need for mechanical ventilation is associated with severe intracerebral hemorrhage and poor neurological prognosis (Greenberg et al., 2022; Witsch et al., 2021).

After adjustment, neither the ICH score nor intracranial hypertension remained statistically associated with mortality, whereas mechanical ventilation was the only factor that remained independently associated with mortality. This finding may reflect the substantial overlap and interdependence among these clinical and radiological markers of disease severity. The lack of statistical significance of the ICH score and intracranial hypertension after adjustment should not be interpreted as evidence that these variables lack prognostic relevance. Rather, the reduced model was intentionally restricted to three clinically relevant predictors because of the small sample size and limited number of mortality events. In addition, the substantial overlap among clinical and radiological markers of disease severity may make it difficult to disentangle their individual contributions to mortality. In particular, the ICH score incorporates several major prognostic components, including the GCS score and hematoma volume, which are themselves closely related to overall neurological severity. Such interrelationships may reduce the precision of individual effect estimates and make independent effects difficult to distinguish when correlated severity markers are considered simultaneously (Zhu et al., 2024).

Methodological Considerations and Uncertainty of Multivariable Estimates

The Firth penalized logistic regression model provided more conservative estimates than the initial conventional logistic regression analysis. An ICH score ≥3 was associated with higher odds of 30-day mortality, but this association did not reach statistical significance (OR = 3.00, 95% CI: 0.66–13.69, p=0.156). Intracranial hypertension was also not significantly associated with 30-day mortality (OR = 0.37, 95% CI: 0.015–9.29, p=0.546). The latter finding should not be interpreted as evidence of a protective effect of intracranial hypertension, as this condition is generally recognized as an adverse prognostic feature after spontaneous intracerebral hemorrhage (Greenberg et al., 2022; Parry-Jones et al., 2024). The lack of statistical significance of these associations may reflect the small sample size and limited number of mortality events, which can reduce statistical power and lead to imprecise effect estimates (Gregório et al., 2018). Accordingly, these findings should be interpreted cautiously and should not be considered evidence against the established prognostic relevance of these clinical features. The very wide confidence intervals further indicate substantial uncertainty in the estimates. In contrast, mechanical ventilation remained strongly associated with 30-day mortality (OR = 99.12, 95% CI: 4.76–2064.41, p=0.003). This association is more appropriately interpreted as a marker of severe neurological and systemic illness among patients requiring ventilatory support, rather than as evidence of a harmful causal effect of mechanical ventilation itself.

Survival Analysis

Kaplan–Meier survival analysis highlighted the strong prognostic role of the ICH score, GCS score, and hematoma volume. Patients with an ICH score ≥3 had significantly shorter median survival compared with those with lower scores. Similarly, a GCS score ≤8 and a hematoma volume >30 mL were associated with significantly reduced survival. These findings are consistent with the pathophysiological mechanisms of ICH and align with multiple multicenter studies reporting progressively reduced survival with increasing ICH score and hemorrhagic burden.

Discriminative Performance of the ICH Score

The ICH score demonstrated moderate discriminative ability for mortality in our cohort, with an area under the receiver operating characteristic curve (AUC) of 0.714. This performance is broadly consistent with that reported in previous validation studies, although discrimination may vary according to study populations, outcome definitions, and clinical settings. At the prespecified threshold of ≥3, the ICH score showed a sensitivity of 57.9% and a specificity of 85.0%, with a positive predictive value (PPV) of 88.0% and a negative predictive value (NPV) of 53.1%. Thus, although this threshold provided relatively good specificity and a high PPV in our cohort, its moderate sensitivity indicates that a substantial proportion of patients who died had an ICH score below 3. The score therefore appears useful for risk stratification but should not be interpreted as

sufficiently sensitive to identify all patients at high risk of death. Consistent with current recommendations, the ICH score should be used as an adjunct to comprehensive clinical assessment rather than as a standalone criterion for prognostic decision-making or treatment limitation.

Clinical Implications

In low- and middle-income countries such as the Democratic Republic of the Congo, access to advanced neuroimaging, invasive intracranial pressure monitoring, and specialized neurocritical care remains limited. In this context, the ICH score may provide a simple and readily applicable tool for early risk stratification at admission, particularly where advanced prognostic resources are not readily available (Greenberg et al., 2022; Hwang et al., 2024). In our cohort, the score demonstrated moderate discriminative ability (AUC = 0.714), with relatively high specificity but limited sensitivity at the prespecified threshold of ≥3. These findings suggest potential value for risk stratification, but the score should not be used in isolation for prognostic decision-making, treatment limitation, or allocation of critical care resources, particularly given the absence of an independent association with mortality after penalized multivariable adjustment. Rather, it should complement comprehensive clinical and radiological assessment (Hwang et al., 2024). Further prospective multicenter studies with external validation are needed before the ICH score can be routinely recommended for clinical decision-making in sub-Saharan African settings.

Study Limitations

This study has several limitations. First, the relatively small sample size and limited number of mortality events may have reduced the statistical power of multivariable analyses and contributed to imprecision and instability of effect estimates, as reflected by the wide confidence interval for the association between mechanical ventilation and mortality. Second, although the multicenter design enhances the representativeness of the study population, differences in diagnostic, therapeutic, and critical care practices across institutions may have introduced clinical heterogeneity. Third, several potentially relevant prognostic factors were not available or were not included in the analyses, including specific treatment strategies, time to intervention, hematoma expansion, and subsequent medical complications, leaving the possibility of residual confounding. Fourth, although the proportional hazards assumption was formally assessed using Schoenfeld residuals, the relatively small sample size and number of events may have limited the robustness and precision of the survival estimates. Finally, the absence of external validation limits the generalizability of the prognostic performance of the ICH score to other sub-Saharan African populations. Despite these limitations, this study provides original data on mortality and prognostic factors among patients with intracerebral hemorrhage admitted to intensive care units in a relatively understudied African setting.

CONCLUSION

This multicenter study conducted in Kinshasa found a high mortality rate among patients with spontaneous intracerebral hemorrhage admitted to intensive care units, underscoring the severe prognosis of this condition in this setting. Mechanical ventilation was independently associated with mortality after adjustment and should be interpreted primarily as a marker of severe clinical status rather than as a causal determinant of death. An ICH score ≥3 was associated with mortality and shorter survival in univariable analyses, but this association was no longer statistically significant after penalized multivariable adjustment, likely reflecting the substantial overlap among clinical and radiological markers of disease severity. The ICH score demonstrated moderate discriminative ability for mortality (AUC = 0.714), with relatively high specificity but limited sensitivity at the prespecified threshold of ≥3. Therefore, the ICH score may be useful for early risk stratification in resource-limited settings, but it should complement rather than replace comprehensive clinical assessment and should not be used as a standalone criterion for prognostic decision-making. Larger prospective multicenter studies incorporating standardized radiological assessment and longer-term functional outcomes are needed to confirm these findings and establish the external validity of the ICH score in sub-Saharan African populations.

Use of Artificial Intelligence (AI) Declaration: The authors acknowledge that parts of this manuscript were translated with the assistance of artificial intelligence (ChatGPT); however, all translated sections were subsequently reviewed and edited to ensure linguistic accuracy.

Acknowledgments: We thank all heads of intensive care units in the participating hospitals who facilitated data collection, particularly Dr. Jean-Jacques Kalongo, Joe Lungela, Trésor Mampangula, Patrick Kobo, Michel Way, and Albert Mbayo.

Authors' Contributions:

i. **Conceptualization:** IE
ii. **Methodology:** IE, FM, BB
iii. **Formal analysis:** IE, EK
iv. **Investigation:** IE, OB, PN, HK, HN, JI
v. **Data curation:** IE, EK, DK
vi. **Writing – original draft:** IE
vii. **Writing – review & editing:** IE, EK, FM, BB, JN, MB, WM
viii. **Visualization:** PM
ix. **Supervision:** BB, JN, MB, FM
x. **Project administration:** IE

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Approval: The study protocol was approved by the Ethics Committee of the School of Public Health of the University of Kinshasa (Approval No. ESP/CE/126/2025).

Informed Consent and Anonymity: Informed consent was obtained from all participants (or their legal representatives), and all data were analyzed anonymously to ensure the confidentiality of medical information.

Funding: This study received no external funding from public, private, or commercial institutions.

Conflicts of Interest: The authors declare that they have no conflicts of interest.

ORCID iDs:

Ebondo, I.[1]: Nil identified.
Mbuyi, F.[1,2]: Nil identified.
Ilunga, J.-P.[1]: Nil identified.
Kandongo, D.[1]: Nil identified.
Kwama, H.[1,3]: Nil identified.
Kam, E.[4]: Nil identified.
Ngoyi, P.[1]: Nil identified.
Mukuna, P.[1]: Nil identified.
Buti, O.[1,4]: Nil identified.
Ngoy, H.[5]: Nil identified.
Mbombo, W.[1]: Nil identified.
Bula Bula, M.[1]: Nil identified.
Nsiala, J.[1]: Nil identified.
Barhayiga, B.[1]: Nil identified.

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