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Survival and Predictors of Mortality Among Stroke Patients in Kinshasa (DRC): A Prospective Cohort Study

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ABSTRACT

Background: Stroke is a leading cause of mortality and severe disability in low- and middle-income countries. In the Democratic Republic of the Congo (DRC), longitudinal data and modeled survival estimates for in-hospital stroke patients remain extremely scarce.

Objective: To evaluate in-hospital survival and identify independent predictors of mortality among hospitalized stroke patients in the Gombe Health Zone, Kinshasa.

Methods: A prospective cohort study was conducted from August 2025 to June 2026 at the Renaissance University Hospital Center (CHUR) and Ngaliema University Hospital. A total of 250 consecutive patients with confirmed acute stroke were followed. Overall and cumulative survival rates were estimated using the Kaplan-Meier method (Log-Rank test). Independent predictors of mortality were identified via multivariate Cox proportional hazards regression analysis.

Results: The mean age of patients was 57.3 ± 13.3 years, with a marked male predominance (65.6%). Ischemic stroke accounted for 57.2% of cases and hemorrhagic stroke for 42.8%. Overall, in-hospital mortality reached 53.2% (n = 133), with a median overall survival time of 14.5 days (95% CI: 11.2 – 17.8). Survival was significantly worse in hemorrhagic strokes compared to ischemic strokes (median survival: 12.0 days vs. 29.0 days; Log-Rank p = 0.002). In multivariate Cox regression, initial neurological severity at admission (Glasgow Coma Scale < 8; aHR = 3.41 [95% CI: 2.15 – 5.41]; p < 0.001), hemorrhagic stroke subtype (aHR = 2.51 [95% CI: 1.62 – 3.89]; p = 0.001), early seizures (aHR = 2.67 [95% CI: 1.58 – 4.51]; p = 0.002), and severe secondary brain insults of systemic origin (SBISO / ACSOS; aHR = 3.16 [95% CI: 1.98 – 5.04]; p < 0.001) were major independent predictors of mortality.

Conclusion: In-hospital stroke mortality in the Gombe Health Zone is exceptionally high and occurs early. Aggressive and protocolized management of secondary systemic brain insults, strict blood pressure control, and the establishment of dedicated Stroke Units represent priority interventions to reduce this burden.

Keywords: Stroke, Survival, Cox Model, Kaplan-Meier, In-hospital Mortality, Secondary Brain Insults, Kinshasa.

1. Introduction

Stroke is defined by the World Health Organization (WHO) as rapidly developing clinical signs of focal or global disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin. Worldwide, stroke stands as the second leading cause of death and the third leading cause of disability-adjusted life years (DALYs). Over 12 million new stroke cases occur annually, resulting in approximately 6.5 million deaths.

This burden is disproportionately borne by low- and middle-income countries (LMICs), which account for nearly 70% of stroke-related deaths. In Sub-Saharan Africa, the epidemiological landscape is characterized by an accelerated epidemiological transition and a "double burden" of disease—combining persistent infectious diseases with a surge in non-communicable cardiovascular pathologies. The stroke phenotype in Sub-Saharan Africa exhibits striking characteristics: early onset (affecting young working-age individuals between 45 and 60 years), an unusually high frequency of hemorrhagic strokes (30% to 50% of cases), and exceptionally high early mortality.

In the Democratic Republic of the Congo (DRC), specifically within the capital city of Kinshasa, stroke care faces severe structural bottlenecks: delayed hospital presentation, financial barriers to emergency brain imaging (CT/MRI), a critical shortage of specialized Stroke Units, and the absence of universal health coverage. Although in-hospital mortality is known to be very high (exceeding 50% in major referral centers such as CHUR), most previous local studies were limited to cross-sectional descriptions without detailed time-to-event survival modeling. This prospective cohort study aimed to evaluate in-hospital survival among stroke patients in the Gombe Health Zone, Kinshasa, and to establish independent predictors of mortality using the Cox proportional hazards model.

2. Materials and methods

2.1. Study Design and Setting

This was a prospective, comparative, and analytical cohort study conducted over an 11-month period from August 2025 to June 2026. The study was carried out in two tertiary referral hospitals in the Gombe Health Zone, Kinshasa: The Renaissance University Hospital Center (CHUR, formerly Hôpital Maman Yemo) and Ngaliema University Hospital.

2.2. Study Population and Eligibility Criteria

The study population comprised all patients admitted to emergency departments or intensive care/neurology wards with acute stroke during the study period.

- **Inclusion criteria:** (1) Age ≥ 18 years; (2) Diagnosis of stroke confirmed by brain neuroimaging (CT scan or MRI) or validated clinically by a senior neurologist/internist; (3) Hospital admission within 7 days of symptom onset.

- **Exclusion criteria:** Neurological deficits caused by brain tumors, CNS infections (abscess, meningitis), or traumatic brain injury, as well as incomplete records lacking primary endpoint data.

2.3. Sampling and Sample Size

Sampling was consecutive and exhaustive. The minimal sample size was calculated using Schoenfeld's formula for Cox survival models, ensuring 80% statistical power ($1 - \beta = 0.80$) with a two-tailed alpha level of 5% ($\alpha = 0.05$). A total of 250 patients met all criteria and were included in the final cohort.

2.4. Data Collection and Study Variables

Data were collected digitally at admission and monitored daily throughout hospitalization using KoboCollect:

- **Sociodemographic data:** Age, sex, marital status, education level, occupation.
- **Baseline comorbidities and risk factors:** Hypertension, diabetes mellitus, cigarette smoking, alcohol consumption, sickle cell disease, HIV status, heart disease.
- **Clinical parameters at admission:** Systolic and diastolic blood pressure, Glasgow Coma Scale (GCS) score, presence of early onset seizures, NIHSS score, pre-hospital delay.
- **Secondary Brain Insults of Systemic Origin (SBISO / ACSOS):** Hyperglycemia (> 180 mg/dL), hyponatremia (< 135 mEq/L), hypoxemia (SpO2 < 90%), hyperthermia (> 38.0°C), extreme hypotension or hypertension. SBISO severity was classified as minor, moderate, or severe.
- **Primary Endpoint:** Survival time (in days) from admission until in-hospital death or discharge (censored).

2.5. Statistical Analysis and Survival Modeling

Data analysis was performed using R software (version 4.3.2) with the survival and survminer packages. Continuous variables were expressed as mean ± standard deviation (SD) or median (IQR), and categorical variables as frequencies and percentages.

Cumulative survival probabilities were estimated using the non-parametric **Kaplan-Meier** method, and survival curves were compared using the **Log-Rank test**.

To evaluate prognostic factors, univariate Cox regression analysis was performed to calculate crude Hazard Ratios (HR). Variables with $p < 0.10$ in univariate analysis were entered into a multivariate **Cox proportional hazards model**. The model fit the following hazard equation:

$$h(t)=h0(t)\times\exp(\beta1XGCS\leq8+\beta2XHemorrhagic+\beta3XSeizures+\beta4XSevere\_SBISO)$$

The proportional hazards assumption was verified using Schoenfeld residuals ($p > 0.05$ for all covariates). Statistical significance was defined as $p < 0.05$.

3. Results

3.1. Cohort Baseline Characteristics

The final cohort included 250 patients. The mean age was 57.3 ± 13.3 years (range: 24 to 88 years). A pronounced male predominance was observed (164 men, 65.6%; male-to-female ratio: 1.9). Hypertension was the single most prevalent cardiovascular risk factor (82.4%), followed by diabetes mellitus (28.8%) and tobacco smoking (21.2%).

Table 1: Baseline Sociodemographic, Clinical, and Neuroimaging Characteristics (N = 250)

Variables / Characteristics	Count (n) / Mean	Percentage (%) / SD
Age (years) (Mean ± SD)	57.3 years	± 13.3 years
• < 50 years	68	27.2%
• 50 – 65 years	112	44.8%
• > 65 years	70	28.0%
Sex		
• Male	164	65.6%
• Female	86	34.4%
Stroke Subtype		
• Ischemic Stroke	143	57.2%

• Hemorrhagic Stroke (ICH / SAH)	107	42.8%
Neurological Severity (GCS)		
• Severe (GCS ≤ 8)	76	30.4%
• Moderate / Mild (GCS 9 – 15)	174	69.6%
Severe SBISO / ACSOS at Admission	88	35.2%
Early Acute Seizures	42	16.8%

3.2. In-Hospital Mortality and Kaplan-Meier Survival Analysis

During hospital follow-up, 133 deaths were recorded, resulting in an overall in-hospital mortality rate of **53.2%** (95% CI: 47.0% – 59.4%). The median overall survival time for the entire cohort was **14.5 days** (95% CI: 11.2 – 17.8 days).

Critical Period of Mortality: Over 60% of all in-hospital deaths occurred within the first 7 days of admission (hyperacute phase), highlighting the devastating impact of primary brain injury, massive cerebral edema, and early herniation.

Table 2: Kaplan-Meier Cumulative Survival Probabilities During Hospitalization

Time (Days)	Patients at Risk	Cumulative Deaths (n)	Survival Probability (%)	95% Confidence Interval
Day 1	250	28	88.8%	[84.9% – 92.9%]
Day 3	222	58	76.8%	[71.6% – 82.3%]
Day 7	192	84	66.4%	[60.6% – 72.7%]
Day 14	128	112	50.2%	[43.9% – 57.3%]
Day 28	45	133	38.5%	[31.2% – 47.4%]

Stratified survival analysis revealed a major divergence by stroke subtype: median survival for hemorrhagic stroke was only **12.0 days**, compared to **29.0 days** for ischemic stroke. This difference was statistically significant (Log-Rank test: p = 0.002).

3.3. Independent Predictors of Mortality (Cox Regression Model)

Univariate and multivariate Cox proportional hazards regression analyses identifying risk factors for in-hospital mortality are summarized in Table 3.

Table 3: Univariate and Multivariate Cox Proportional Hazards Regression Analysis

Explanatory Variables	Crude HR (95% CI)	p-value	Adjusted HR (95% CI)	p-value
Age > 65 years (vs. ≤ 65 years)	1.45 [1.02 – 2.08]	0.038	1.21 [0.82 – 1.78]	0.332
Male Sex (vs. Female)	1.12 [0.78 – 1.61]	0.541	—	—
GCS Score ≤ 8 (vs. > 8)	4.25 [2.88 – 6.28]	< 0.001	**3.41 [2.15 – 5.41]**	**< 0.001**
Hemorrhagic Stroke (vs. Ischemic)	1.82 [1.24 – 2.67]	0.002	**2.51 [1.62 – 3.89]**	**0.001**
Early Seizures (Yes vs. No)	2.95 [1.82 – 4.78]	< 0.001	**2.67 [1.58 – 4.51]**	**0.002**
Severe SBISO / ACSOS (vs. Mild/Absent)	3.88 [2.52 – 5.96]	< 0.001	**3.16 [1.98 – 5.04]**	**< 0.001**
Hyperglycemia (> 180 mg/dL)	2.10 [1.41 – 3.12]	< 0.001	1.38 [0.89 – 2.14]	0.152

In multivariate Cox regression, four factors emerged as **major independent predictors of in-hospital mortality**:

1. **Glasgow Coma Scale ≤ 8 at admission:** Increased the risk of death 3.41-fold (aHR = 3.41 [2.15 – 5.41]; p < 0.001).
2. **Severe Secondary Brain Insults (SBISO / ACSOS):** Increased mortality risk 3.16-fold (aHR = 3.16 [1.98 – 5.04]; p < 0.001).

3. **Early onset seizures:** Associated with a 2.67-fold increase in mortality risk (aHR = 2.67 [1.58 – 4.51]; p = 0.002).

4. **Hemorrhagic stroke subtype:** Carried a 2.51-fold higher risk of death compared to ischemic stroke (aHR = 2.51 [1.62 – 3.89]; p = 0.001).

4. Discussion

This prospective cohort study provides rigorous quantitative evidence regarding survival and mortality determinants among acute stroke patients in a Congolese tertiary hospital setting. The primary finding is the severe short-term mortality, characterized by an overall in-hospital case fatality rate of 53.2% and a median survival of only 14.5 days.

This mortality rate is markedly higher than figures reported in high-income countries, where 30-day in-hospital stroke mortality is typically maintained below 15% to 20%. However, our findings align closely with data from other Sub-Saharan African cohorts. In Uganda, Nakibuuka et al. observed similarly high early mortality, and previous studies in the DRC by Kamabu et al. and Tshikwela et al. highlighted the heavy burden of acute neurovascular mortality. This excess mortality is driven by a combination of pre-hospital delays (most patients presenting > 24 hours post-ictus), initial stroke severity, financial barriers to emergency interventions, and the absence of dedicated Stroke Units.

The high proportion of hemorrhagic strokes (42.8%) in our cohort contrasts with Western cohorts (15–20%) but reflects the typical Sub-Saharan African stroke profile. This high prevalence is directly linked to uncontrolled primary hypertension (82.4% in our series), leading to lipohyalinosis and rupture of deep penetrating cerebral arterioles.

From a predictive perspective, our multivariate Cox model underscores the critical impact of Secondary Brain Insults of Systemic Origin (SBISO / ACSOS). Severe SBISO (hyperglycemia, hypoxemia, hyponatremia, hyperthermia) tripled the risk of in-hospital death. Pathophysiologically, hyperglycemia and fever exacerbate anaerobic metabolism, lactic acidosis, and free radical generation, expanding ischemic penumbra damage. Early, protocolized control of these physiological parameters represents an affordable, high-impact intervention for resource-limited settings.

5. Conclusion and recommendations

In-hospital stroke mortality in Kinshasa is exceedingly high, concentrated within the first week of admission. Initial coma severity (GCS ≤ 8), hemorrhagic stroke subtype, early seizures, and severe systemic secondary brain insults represent key independent predictors of death.

Based on these findings, we recommend:

- **Public Health Authorities & Ministry of Health:** Strengthen primary hypertension screening programs and subsidize emergency CT scanning to eliminate financial delays.

- **Hospital Management (CHUR & Ngaliema):** Establish dedicated, low-cost Stroke Units with standardized SBISO monitoring protocols (glycemic, thermal, and BP control).

- **Clinicians:** Implement routine dysphagia screening before oral intake to prevent aspiration pneumonia and avoid aggressive acute BP lowering that compromises cerebral perfusion.

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