



Hemorrhagic Stroke: Prognostic Factors for Mortality in Operated Cases

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Abstract

Stroke is the second leading cause of death worldwide. Early management remains a major challenge, and understanding prognostic factors is essential for optimizing therapeutic strategies. The objective of this study was to determine the prognostic factors associated with short-term mortality in surgically managed hemorrhagic stroke patients.

Method and Result: This retrospective analytical study was conducted at the University Hospital Joseph Ravoahangy Andrianavalona in Antananarivo, Madagascar. The study covered a two-year period from January 2022 to January 2024. All surgically managed hemorrhagic stroke cases were included. The Hemphill Intracerebral Hemorrhage Score (ICH score) was used for clinical and prognostic evaluation. Statistical analysis included Pearson's Chi-square test for comparison of proportions and Student's t-test for comparison of means. Odds ratios (OR) with 95% confidence intervals (CI) were calculated with a significance threshold set at $p < 0.05$.

Poor prognostic factors identified were: systolic blood pressure greater than 140 mmHg on admission (4.38-fold increase; $p < 0.05$), the association of three modifiable risk factors including obesity, alcohol consumption, and smoking (OR 2.5 [1.03-6.6]; $p < 0.05$), posterior fossa hematoma location (OR 4; 95% CI 1.02-18.15; $p < 0.05$), hematoma volume greater than 80 ml (OR 3.3 [1.14-9.8]; $p < 0.05$), low Glasgow Coma Scale score (OR 12.6 [3.7-42.8]; $p < 0.05$), and an ICH score equal to 4 (OR 9; 95% CI 1.01-94.9). The overall mortality rate in this study was 50.8%. A significant association between delayed management and mortality was found in patients operated on after more than 72 hours (OR 4.3; 95% CI 1.02-18.8).

Conclusion: The short-term prognosis of hemorrhagic stroke remains poor in our setting. Early identification and appropriate management of modifiable risk factors, particularly hypertension, remain essential preventive strategies. Surgical management within the first twenty-four hours appears to significantly improve patient outcomes.

Keywords: Hemorrhagic Stroke; Arterial Hypertension; Surgery; Prognosis

Abbreviations

ICH: Intracerebral Hemorrhage Score; GCS: Glasgow Coma Scale Score; HBP: High Blood Pressure; NA: Not Applicable (Number of Cases Less Than 5); NS: Not Significant; NGC: Basal Ganglion; SBP: Systolic Blood Pressure.

Introduction

Hemorrhagic stroke is a severe condition associated with major neurological sequelae and high mortality. Despite advances in medical and surgical management, the one-month mortality rate remains around 40%, even among patients who undergo surgical treatment [1-4]. In our population, the prognostic factors associated with mortality in surgically managed hemorrhagic stroke have not yet been specifically investigated. Identifying these prognostic factors is essential for optimizing therapeutic strategies and improving patient outcomes. Therefore, the aim of this study was to determine the prognostic factors associated with mortality in patients undergoing surgical management for hemorrhagic stroke in our center.

Methods

This is a retrospective and analytical study carried out in three departments of the university hospital Joseph Ravoahangy Andrianavalona: neurosurgery, surgical intensive unit care, and medical intensive unit care and toxicology departments over a 24-month period.

We included all patients with hemorrhagic stroke confirmed by brain CT scan who underwent surgical treatment, including hematoma evacuation, decompressive craniectomy, or external ventricular drainage.

Surgical indications included large hematoma volume greater than 30 cc, neurological deterioration with a Glasgow Coma Scale score between 9 and 12, mass effect with a midline shift greater than 5 mm, posterior fossa compression, acute hydrocephalus requiring external ventricular drainage, and surgically accessible hematomas according to neurosurgical evaluation. Patients presenting with extremely severe neurological status, extensive brainstem involvement, delayed presentation, or major comorbidities could be excluded from surgery depending on clinical evaluation

We collected demographic, clinical, and radiological data.

The analysis of the association with mortality was performed according to the following variables: age, cardiovascular risk factors, preoperative Glasgow score, blood pressure, CT signs, ICH score.

The ICH (Intracerebral Hemorrhage Score), which is based on five elements (GCS score, hematoma volume, ventricular hemorrhage, age and infratentorial origin). It is the most commonly used score to assess the prognosis of patients with hemorrhagic stroke. It is correlated with 30-day mortality. It ranged from zero to six and mortality increased significantly with the score [5].

Data entry and graphical presentation were performed on Word and Excel 2007 software. At the end of the analysis, a verification of the entered data was carried out in order to eliminate duplicates and complete the non-entered data.

Epi Info7© version 1.3.4 of the Center for Disease and Prevention (USA) was used for the statistical analysis of the data. It was used to calculate the odds ratio, the confidence interval and the p-value with a significance threshold set at 0.05:

- The odds ratio = OR (or OR) = $(A \cdot D / B \cdot C)$ was used to assess the strength of the association between a factor and mortality during hemorrhagic stroke. When it is greater than one, the factor is said to increase the risk of death. But when it is less than one, the factor is said to decrease the risk of death, in other words, it is a protective factor against the disease.
- The 95% Confidence Interval (CI) is an interval of values that has a 95% chance of containing the true value of the estimated parameter. If the 95% CI is greater than one, the relationship is significant
- the p, the regression or estimation coefficient that quantifies the relationship between the dependent variable and the explanatory variables. If $p < 0.05$, the relationship is significant.

The student's t test was used to compare two means of a quantitative variable and the chi-square test for the two categorical variables that are expressed as a percentage (%).

Result

A total of 116 patients with hemorrhagic stroke underwent surgical management during the study period. Among them, 59 patients died, corresponding to an overall mortality rate of 50.8%.

The highest mortality rate was observed among patients aged between 46 and 60 years. Although age appeared to be associated with mortality (OR 1.03 [0.4-2.6]), the association was not statistically significant ($p > 0.05$) (Table I).

Mortality was higher among patients presenting with three or more cardiovascular risk factors (CVRFs). The coexistence of three cardiovascular risk factors was significantly associated with mortality (OR 2.5 [1.03-6.6]; $p < 0.05$) (Table II).

Age range	Deceaseds (N = 59)	Percentage (%)	OR	P
15-30	1	33,33	NA	0,3
31-45	13	50	1	NS
46-60	27	50,94	1,03[0,4-2,6]	0,4
61-75	15	48,39	0,9[0,3-2,6]	0,4
> 75	2	100	NA	0,2

Table I: Distribution of deceased patients according to age.

Risk Factor (RF)	Deceaseds (N = 59)	Percentage (%)	OR	P
HBP	15	41,67	1	NS
2RF	11	42,31	1,02[0,3-3,2]	0,4
3RF and more	29	64,86	2,5[1,03-6,6]	0,02
SBP (mmhg)				
Low (< 90)	1	0	NA	0,2
Normal (90-139)	14	30,43	1	NS
Grade I (140-159)	10	58,82	3,26[1,03-10,33]	0,02
Grade II (160-179)	11	64,71	4,19 [1,29-13,58]	0,009
Grade III (>180)	23	65,71	4,38 [1,7-11,2]	0,0009

Table II: Distribution of patients who died according to Cardio vascular risk factor.

Patients with a preoperative Glasgow Coma Scale (GCS) score lower than 8 had the highest mortality rate (80.77%). A low preoperative GCS score was significantly associated with mortality (OR 12.6 [3.7-42.8]; $p < 0.05$) (Table III).

Glasgow	Deceaseds (N = 59)	Percentage (%)	OR	P
3-7	42	80,77	12,6[3,7-42,8]	<0,00001
8-12	12	27,27	1,12[0,3-3,7]	0,4
13-15	5	25	1	NS
ICH SCORE				
1	6	40	1	NS
2	30	46,15	1,2[0,4-4,02]	0,34
3	16	57,14	2[0,5-7,1]	0,15
4	6	85,71	9[1,01-94,9]	0,03
5	1	100	NA	0,2

Table III: Distribution of patients who died according to the preoperative Glasgow score and ICH score.

We observed a significant increase in mortality risk in patients presenting with systolic blood pressure greater than 140 mmHg on admission. The highest risk was observed in patients with systolic blood pressure above 180 mmHg, with a 4.38-fold increase in mortality risk ($p < 0.05$) (Table IV).

Hematoma localization	Deceaseds (N = 59)	Percentage (%)	OR	P
Posterior Fossa	10	76,92	4,3[1,02-18,15]	0,02
Lobar	17	43,58	1	NS
NGC*	31	52,54	1,4[0,6-3,2]	NS
NGC, lobar	1	20	NA	NS
Hematoma volume (ml)				
<30	26	42,62	1	NS
30-80	18	52,94	1,4[0,6-3,2]	NS
>80	15	71,43	3,3 [1,14-9,8]	0,01
Ventricular Flooding	41	50,62	0,9[0,4-2,13]	0,46
Acute Hydrocephalus	31	59,62	1,8[0,9-3,9]	0,04
Cerebral Engagement	23	45,10	0,6[0,3-1,3]	0,13

Table IV: Distribution of patients who died according to the characteristics of the hematoma.

Patients presenting with posterior fossa intracerebral hematomas had the poorest prognosis. Posterior fossa location was significantly associated with mortality, with a fourfold increased risk of death (95% CI: 1.02-18.15; $p < 0.05$) (Table IV).

Mortality was particularly high (68.18%) in patients with hematoma volumes greater than 80 ml. Large hematoma volume was identified as a significant predictor of mortality (OR 3.3 [1.14-9.8]; $p < 0.05$) (Table IV).

The mortality rate associated with intraventricular hemorrhage was 50.62%. However, the difference between exposed and unexposed groups was not statistically significant. Similarly, acute hydrocephalus was associated with a mortality rate of 59.62%, although the association with mortality did not reach statistical significance (OR 1.8 [0.9-3.9]). No significant association was observed between brain herniation and mortality.

Higher ICH scores were significantly associated with mortality (OR 9; 95% CI: 1.01-94.9). Mortality reached 100% among patients with an ICH score of 5; however, this result was not statistically applicable because of the small sample size ($n < 5$) (Table III).

A high mortality rate (72.73%) was observed among patients operated on after more than 72 hours. Delayed surgical management was significantly associated with mortality (OR 4.3; 95% CI: 1.02-18.8).

Discussion

Age remains an important factor in the surgical management of hemorrhagic stroke. In our study, patients aged between 46 and 60 years showed a higher risk of mortality, although this association was not statistically significant. Our findings differ from those reported in the literature. A recent meta-analysis demonstrated that surgical management was more beneficial in patients younger than 65 years, whereas mortality increased with advancing age [6]. Similarly, Kim., *et al.* reported lower mortality rates (9.24%) among patients younger than 65 years [7]. The absence of a statistically significant relationship between age and mortality in our study may be explained by sampling variability, differences in inclusion criteria, or the relatively limited sample size.

Several studies have identified associated comorbidities and cardiovascular risk factors as predictors of poor outcome in hemorrhagic stroke [8-11]. Our findings are consistent with previous reports showing that the coexistence of three cardiovascular risk factors significantly increases mortality risk in hemorrhagic stroke patients (OR 2.5 [1.03-6.6]).

Our results are also consistent with those of previous studies demonstrating that lower preoperative GCS scores are associated with increased mortality following neurosurgical management of hemorrhagic stroke, although the thresholds varied across studies. Kim., *et al.* identified a GCS score lower than 9 as a poor prognostic factor [7]. The STICH II trial recommended surgical management

for patients presenting with spontaneous lobar hemorrhage between 10 and 100 ml without intraventricular hemorrhage and with a hematoma located less than 1 cm from the cortical surface, particularly in patients with GCS scores between 9 and 12 or in cases of neurological deterioration after conservative treatment [1]. In our study, low preoperative GCS score was identified as a significant predictor of mortality, suggesting that surgical intervention should not necessarily be delayed until the GCS score falls below 8 [12-14].

Elevated blood pressure is recognized as an aggravating factor for hematoma expansion and rebleeding during the management of hemorrhagic stroke [15]. Marked hypertension has consistently been associated with increased mortality [2,8,11]. In our series, patients presenting with systolic blood pressure above 180 mmHg had a mortality rate of 65.71%, which is consistent with previously reported rates ranging between 30% and 50%. Hypertension was therefore identified as a significant predictor of mortality in our study.

Hematoma location is a well-established prognostic factor included in the ICH score [16-18]. Kalf, *et al.* reported favorable outcomes in 31% of lobar hemorrhages compared with 26% in basal ganglia or cerebellar hemorrhages [19,21]. Similarly, posterior fossa hematoma location was significantly associated with mortality in our study.

Hematoma volume is another major determinant of prognosis in spontaneous intracerebral hemorrhage. Small hematomas are generally associated with favorable outcomes, whereas large hematomas are frequently associated with poor functional and vital prognosis [17,20,22]. In our series, hematoma volume greater than 80 ml was significantly associated with mortality (OR 3.3 [1.14-9.8]), with a mortality rate of 71.43%.

According to Hemphill, *et al.* [5], the ICH score, ranging from 0 to 6, strongly correlates with 30-day mortality. In our study, mortality increased progressively with increasing ICH score. Mortality reached 100% among patients with an ICH score of 5, consistent with the original description of the score. However, only one patient presented with an ICH score of 5, limiting the statistical applicability of this observation. Nevertheless, an ICH score of 4 remained significantly associated with mortality (OR 9; 95% CI: 1.01-94.9).

The very high mortality rate observed in our cohort may also reflect healthcare system limitations frequently encountered in low-resource settings. Delayed referral pathways, restricted access to emergency neuroimaging, limited perioperative resources, delayed surgical intervention, reduced intensive care unit availability, financial barriers to care, and insufficient rehabilitation facilities probably contributed to poorer outcomes compared with larger international cohorts.

Conclusion

This study demonstrates that the mortality rate associated with hemorrhagic stroke in our setting remains significantly higher than those reported in the literature. The main poor prognostic factors identified were systolic blood pressure greater than 140 mmHg on admission, the coexistence of three modifiable cardiovascular risk factors including obesity, alcohol consumption, and smoking, posterior fossa hematoma location, hematoma volume greater than 80 ml, low preoperative Glasgow Coma Scale score, and an ICH score of 4.

Knowledge of these prognostic factors is essential to improve clinical practice and optimize patient management.

Therefore, preventive strategies focusing on lifestyle modification, including regular physical activity, moderation of alcohol consumption, and smoking cessation, remain essential. Early detection and appropriate management of hypertension are also crucial in reducing the burden of hemorrhagic stroke. Increasing public awareness of warning signs among at-risk populations is important to reduce delays in medical consultation and management. Early surgical intervention, particularly within the first twenty-four hours, may improve patient survival and overall prognosis. Finally, a prospective multicenter study with a larger nationwide sample is needed to validate and strengthen the findings observed in our practice.

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Author Contributions

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Availability of Data and Materials

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

Ethics Approval and Consent to Participate

This retrospective analytical study was conducted using anonymized patient data collected from hospital records at the University Hospital Joseph Ravoahangy Andrianavalona. Patient confidentiality was respected throughout the study. Ethical approval was obtained according to institutional requirements.

Patient data was analyzed for this review article consent to participate was not necessary.

Consent for Publication

The manuscript does not contain any individual person's data.

Competing Interests

No conflict of interest.

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