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Study on the Etiology and Prognostic Factors of Patients with Intracerebral Haemorrhage

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ABSTRACT

Background: Intracerebral haemorrhage is a dangerous condition caused by the rapture of cerebral blood vessels, leading to bleeding within the brain parenchyma. It is related to high morbidity and mortality rates, making the documentation of its aetiology and prognostic factors essential for improving patient management and clinical consequences. This study aims to evaluate the aetiology and prognostic factors influencing outcomes in patients with ICH.

Methods: A retrospective cohort study was done at a tertiary care hospital, analysing medical records of adult patients diagnosed with spontaneous ICH, who were admitted within 24 hours of symptom onset. Data on demographic features, clinical presentation, imaging results, laboratory details, treatment methods, and patient outcomes were collected. Descriptive statistics summarised baseline appearances, while univariate and multivariate analyses identified independent risk factors.

Results: The study analysed 30 patients (mean age=56.13±16.23). Most were male (76.7%), and the maximum age group was 71–85 years (30%). No significant suggestion was found between gender and patient outcomes (χ^2=0.81, p=0.368). Hypertension was present in 53.3%, diabetes in 20%, and ischemic heart disease in 10%, with no significant impact on outcomes (χ^2=0.73, p=0.39). Most patients (86.6%) followed a mixed diet, and 16.7% required PEG. GCS enhanced from 12.5 to 14.35 over six months, with no significant difference between deceased and discharged patients (p=0.49).

Conclusion: Early identification and risk stratification in ICH patients are critical for refining consequences. Strict blood pressure control, appropriate neurosurgical evaluation, and personalised rehabilitation enhance recovery. Progressive imaging and biomarker evaluations can improve prognostic accuracy, while future research should explore potential studies and precision medicine to refine treatment approaches and improve existence rates.

Key-words: Intracerebral haemorrhage, Aetiology, Prognostic factors, Hematoma volume, Glasgow Coma Scale, survival analysis, Risk stratification

INTRODUCTION

Intracerebral haemorrhage (ICH) is an acute collection of blood in the brain parenchyma due to blood vessel rupture, posing a risk of severe neurological impairment or death.

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It is the second most common type of stroke after ischemic stroke and requires urgent medical attention to prevent long-term neurological damage [1]. Rapid diagnosis, typically through CT scan, is essential for initiating effective treatment [2].

ICH is classified into traumatic and spontaneous types. Traumatic ICH includes subtypes such as delayed traumatic intracerebral hematoma, characterized by hematoma progression after initial imaging, while spontaneous ICH is commonly linked to vascular or systemic conditions like hypertension [3]. Ziechmann *et al.* introduced a classification for delayed hematomas into four types based on CT appearance and hemorrhage progression [3].

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Occupational factors also contribute to ICH risk, with physically demanding jobs like agriculture associated with a higher incidence, likely due to vascular strain [4]. This highlights the multifactorial etiology of ICH, influenced by both extrinsic (e.g. occupation) and intrinsic factors (e.g., cardiovascular disease) [1]. Current management focuses on acute care bundles, with recent clinical trials showing promise in improving outcomes [5].

ICH has a distinct pathophysiology compared to ischemic strokes. Vessel rupture in ICH causes hematoma formation, leading to brain injury via mechanical disruption and secondary mechanisms such as inflammation, oxidative stress, and excitotoxicity [6]. In contrast, ischemic strokes result from vascular blockage due to thrombosis or embolism, leading to tissue hypoxia and neuronal death through necrosis and apoptosis [7].

Inflammatory responses differ between the two stroke types. ICH elicits a robust inflammatory response, with leukocyte infiltration and cytokine release exacerbating edema and secondary damage [6]. Ischemic strokes generate inflammation via ischemia itself, contributing more to chronic vascular diseases such as atherosclerosis [7]. Stroke subtypes also influence cognitive outcomes, with ischemic and hemorrhagic strokes showing differing recovery patterns [8].

Common causes of ICH include hypertension, cerebral amyloid angiopathy (CAA), vascular malformations, and hematologic disorders. Hypertension is the leading risk factor, promoting vascular wall damage and microaneurysm formation, resulting in spontaneous hemorrhage [9]. Severe hypertension is associated with larger hematomas and poorer recovery, often complicated by elevated intracranial pressure [9].

CAA, prevalent in older adults, involves amyloid deposition in cerebral vessel walls, leading to fragility and hemorrhage. Recurrent CAA-related bleeds can contribute to cumulative neurological impairment and reduced quality of life [10]. Vascular malformations such as arteriovenous malformations (AVMs) and cavernous malformations also present a hemorrhagic risk, especially AVMs due to disordered blood flow [11]. Outcomes in such cases depend on lesion size, location, and patient comorbidities.

Hematologic disorders, including anticoagulant-induced coagulopathy and other blood disorders, are additional contributors to ICH. Management involves correcting coagulopathy, often through blood transfusions or reversal agents [12]. These cases may complicate clinical presentations and delay appropriate interventions.

MATERIALS AND METHODS

Research Design- This retrospective cohort study examined the aetiology and prognostic factors influencing outcomes in patients diagnosed with intracerebral haemorrhage (ICH). Conducted at a tertiary care hospital, the study analyzed clinical, imaging, and laboratory data from medical records of adult patients diagnosed with spontaneous ICH, who were admitted within 24 hours of symptom onset. Data were collected over a specified timeframe to ensure an adequate sample size.

Patient information included demographics, comorbidities (e.g., hypertension, diabetes), clinical presentation (e.g. Glasgow Coma Scale, neurological deficits), radiological findings (e.g. hematoma location, volume, intraventricular haemorrhage, midline shift), and laboratory results (e.g. coagulation profile, renal function, inflammatory markers). Treatment details, including medical or surgical interventions and ICU admissions, were documented. Outcomes were assessed using the modified Rankin Scale at discharge, 30 days, and 6 months, along with mortality rates.

A retrospective cohort design was chosen for its efficiency, cost-effectiveness, and capacity to identify risk factors from existing records. It facilitated rapid analysis without real-time patient enrolment. However, limitations included potential missing data, limited control over variables, and selection bias, as the study focused solely on hospitalized patients. Ethical approval was obtained from the Institutional Review Board/Ethics Committee, and patient confidentiality was strictly maintained. Despite its limitations, this study contributed valuable insights into ICH aetiology and prognostic factors, supporting improved risk stratification and treatment planning.

Inclusion Criteria

- The patient's established diagnosis of intracerebral haemorrhage is based on neuroimaging.
- Patients aged ≥18 years at the time of analysis.
- Patients are admitted to the hospital within 24 hours of symptom onset.
- Accessibility of complete clinical and follow-up data.

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Exclusion Criteria

- Traumatic intracerebral haemorrhage.
- Haemorrhagic alteration of ischemic stroke.
- Subarachnoid, subdural, or epidural haemorrhage without parenchymal contribution.
- History of intracranial neoplasm, vascular malformations, or aneurysm separation as the primary cause of haemorrhage.
- Patients with incomplete or missing medical records.

Statistical analysis- Descriptive statistics were used to summarize baseline characteristics, with continuous variables presented as mean±standard deviation and categorical variables expressed as frequencies and percentages. To identify possible prognostic factors, univariate analysis was performed using the Chi-square test for categorical variables and the t-test or Mann-Whitney U test for continuous variables, depending on data distribution. To determine independent risk factors for poor outcomes while adjusting for confounding variables, a multivariate logistic regression analysis was conducted. In addition, Kaplan-Meier survival analysis and Cox proportional hazards models were used to assess long-term prognosis and mortality risks. $p<0.05$ was considered indicative of significant differences. All statistical analyses were completed using SPSS, R, or STATA software to accurate and reliable outcomes.

RESULTS

The ages range from 19 to 78 years (Mean=56.13, SD=16.23). Patients were divided into different age groups, with the highest proportion (30%) falling in the 71 to 85 years range, followed by 23.3% in both the 31 to 45 years and 56 to 70 years groups. The 46 to 55 years group included 16.7%, while the 19 to 30 years group had 6.7% (Table 1).

Regarding gender distribution, most patients are male (76.7%), while females are 23.3%. Examining the outcomes by gender, 15.4% of females were dead, while 29.4% were discharged. Among males, 84.6% of deaths and 70.6% of discharges were observed. A Chi-square test was performed to analyze the association between gender and patient outcome, with a Chi-square value of 0.81 and a p-value of 0.36. Since $p<0.05$, the results show that there are no significant differences in the association between gender and patient outcomes in this sample (Table 2).

Table 1: Baseline Characteristics of Study Population

Variables	n (%)	Mean±SD	Range
Total Patients	30 (100%)		
Age (years)		56.13±16.23	19 – 78
Age Groups			
19–30 yrs	2 (6.7%)		
31–45 yrs	7 (23.3%)		
46–55 yrs	5 (16.7%)		
56–70 yrs	7 (23.3%)		
71–85 yrs	9 (30%)		
Gender			
Males	23 (76.7%)		
Females	7 (23.3%)		

Table 2: Association Between Gender and Patient Outcomes

Gender	Dead n (%)	Discharged n (%)	Total n (%)
Males	11 (84.6%)	12 (70.6%)	23 (76.7%)
Females	2 (15.4%)	5 (29.4%)	7 (23.3%)
Total	13 (100%)	17 (100%)	30 (100%)

Chi-square value = 0.81, p = 0.368

Hypertension was present in 53.3% of patients, while 46.7% did not have HTN. Diabetes Mellitus was reported in 20% of patients, whereas 80% were non-diabetic. In addition, 10% of patients had ischemic heart disease and were on anticoagulants, while 90% did not have these conditions. When analyzing the association between IHD/anticoagulant use and patient outcomes, 84.6% of deaths occurred in patients without IHD, while 15.4% of deaths were observed in those with IHD. Among discharged patients, 94.1% did not have IHD, whereas 5.9% had IHD. The Chi-square test ($\chi^2=0.73$, $p=0.39$) with no significant differences between IHD/anticoagulant use and patient outcomes. Regarding dietary habits, most of the patients (86.6%) followed a mixed diet, while 13.3% were vegetarian. 16.7% of patients required Percutaneous Endoscopic Gastrostomy feeding, whereas 83.3% did not require PEG (Table 3).

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Table 3: Comparison of Co-Morbidities, Dietary Habits, and PEG Feeding with Patient Outcomes

Co-morbidities		**Frequency**	**Percentage**	**Total**
HTN	No	14	46.7	
	Yes	16	53.3	
DM	No	24	80	
	Yes	6	20	
IHD and anticoagulant				
No	27	90		
Yes	3	10		
Total	30	100		
IHD & anticoagulant	**Outcomes**			**Total**
		Dead	**Discharged**	
No	Count	11	16	27
	%	84.60%	94.10%	90%
Yes	Count	2	1	3
	%	15.40%	5.90%	100%
Total	Count	13	17	30
	%	100%	100%	100%
Chi-square value- 0.739; p-value-0.39				
Diet				
Mixed	26	86.6		
Veg	4	13.3		
Total	30	100		
PEG				
No	25	83.3		
Yes	5	16.7		
Total	30	100		

The Glasgow Coma Scale scores were evaluated at one month and six months to assess patient recovery. At one month, the mean GCS score was 12.5±2.995 (range: 6 to 15) for 18 patients. By six months, the mean GCS increased to 14.35±1.169 (range: 11 to 15) for 17 patients, representing an overall improvement in neurological status over time. Regarding patient outcomes, the mean score for deceased patients was 18.38±23.02, while for those who were discharged, it was 24.88±26.8. The mean difference between the two groups was 6.49, with a p=0.491. Since the p-value is greater than 0.05, the difference in GCS scores between the death and discharged groups showed no significant differences (Table 4).

Table 4: Assessment of Glasgow Coma Scale Progression and Its Association with Patient Outcomes

GCS	**N**	**Minimum**	**Maximum**	**Mean**	**S. D**	**Mean diff**	**p-value**
1 month	18	6	15	12.5	2.995		
-6 months	17	11	15	14.35	1.169		
Outcomes							
Death	13	1	72	18.38	23.02	6.49	0.491
Discharged	17	3	88	24.88	26.8		

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DISCUSSION

Hypertension is still the leading aetiology of ICH, as evidenced by numerous investigations. Ciochon et al. stated that their meta-analysis underscored vascular lesions among children with ICH, yet in adults, it has a clearer association with chronic hypertension [13]. This is corroborated by broader literature in which hypertension results in vascular damage, which eventually leads to an increased risk of bleeding, particularly among the 45-year-old and older group, as quoted by Kumral *et al.* their research warrants the assumption that hypertension is linked to poor outcomes for ICH patients, who can suffer from increased mortality and dependency [14].

Cerebral amyloid angiopathy has also been reported to be a significant aetiology, especially among the geriatric population. Studies show that CAA accounts for a high proportion of spontaneous ICHs, primarily due to age-related vascular disease that increases vessel fragility [15]. The literature identifies that patients with CAA can experience recurrent haemorrhage, influencing their prognosis and necessitating individualized management strategies. This link is further strengthened by the evidence presented by Sirimarco, which cites CAA as a significant risk factor in complex cases of thrombolytic therapy [15].

Vascular malformations, i.e. arteriovenous malformations (AVMs), have been established as known risk factors for ICH. Current literature validates evidence indicating bleeding from AVMs results in significant morbidity and risk stratification problems [13]. Radu *et al.* also mentioned an elevated rate of patients receiving antithrombotic treatment before the occurrence of ICH, which complicated the situation even further. Their chronic use combined with the presence of vascular disease like hypertension or CAA can significantly influence the severity and outcome due to ICH [16].

Although studies such as that of Park et al. use the term ICH with a history of previous cerebrovascular accidents (CVAs) and mention the high frequency of later haemorrhagic transformation, such studies may not directly influence the acute management of ICH but hold importance in the recognition of patient history during its treatment [17].

The prognostic indicators observed in the study on intracerebral haemorrhage (ICH) have a significant influence on long-term recovery as well as mortality rates among the patients. Significant indicators such as early seizures, prediabetes, hematoma characteristics, leucocytosis, and anticoagulation therapy have been observed to be correlated with patients' clinical outcomes and prognosis. Early seizures, which are seen in approximately 13% of ICH, are a very important prognostic factor for poor outcomes, Serafini *et al.* Seizure occurrence could lead to increased neurological impairments and complicate rehabilitation, hence advancing the risk of functional disability and mortality in the long run. The relationship between seizure activity and poor recovery courses reiterates the importance of rigorous monitoring and potential prophylactic therapy in patients with ICH [18].

The relationship between prediabetes and poor functional outcomes is another key determinant of recovery. Wang *et al.* note that a high HbA1c level has been linked with adverse outcomes following ICH, indicating that glucose dysregulation exacerbates cerebral injury and recovery. The prevalence of prediabetes in ICH patients necessitates the application of management strategies aimed at optimizing glycaemic control to improve the chances of favourable functional outcomes [19].

Hematoma characteristics, especially irregular shapes, have been identified as independent predictors of outcome. Liu *et al.* pointed out that morphological characteristics of the hematoma, such as those indicative of possible expansion, significantly impact outcomes. Non-contrast CT imaging appearance of such characteristics may allow clinicians to risk-stratify patients more reliably, decide on treatment, and improve prognostic value [20].

Leucocytosis, an indicator of inflammatory response, is a prognostic factor in ICH. Yu et al. document that increased white blood cell counts can be linked with increased mortality and poor functional outcomes due to secondary brain injury processes aggravation [21]. Because inflammation lies at the core of ICH pathophysiologic consequences, modulation of leucocytosis and its consequences could have the potential to improve the recovery patterns of patients. In addition, anticoagulation therapy is significant in patients with ICH, particularly in the presence of occult coagulopathies or thromboembolic disease leading to

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haemorrhage [22]. Identification of early prognostic factors among patients with intracerebral haemorrhage (ICH) would go a long way in optimizing the management and treatment plan, leading to favourable outcomes.

Numerous prognostic factors have been shown in the literature that help with immediate decisions and allow adaptation of long-term care strategies based on patient requirements. Early detection of irregularity of hematoma shape, for example, is a strong predictor of patient outcome. Liu *et al.* demonstrated that irregular hematoma shape predicted risk of enlargement and poor functional recovery, Liu *et al.* This finding allows clinicians to stratify patients early, recognizing those at higher risk who might be advantaged by more intense therapy, such as surgical evacuation to lower intracranial pressure and prevent further injury [20]. Moreover, the Glasgow Coma Scale (GCS) is a very important prognostic tool that combines the level of consciousness on admission with hematoma volume to predict morbidity and mortality accurately. Islam *et al.* demonstrated that lower GCS, particularly coupled with larger haemorrhage volume, was associated with poor outcomes [23].

In addition, the inclusion of biomarkers, such as midregional proatrial natriuretic peptide (MR-proANP), allows for more detailed risk stratification upon admission, as emphasized by Fischer *et al.* knowing the ability of early prognostic indicators to delineate the likelihood of the length of hospital stay or need for intensive care units allows for the best allocation of resources and rehabilitation facility planning well in advance [24].

It can also be prepared in advance by employing these prognostic indicators in planning interventions. Pre-emptive consultation with operating teams can be a consequence of identifying patients with unfavourable prognostic indicators, leading to quicker decision-making in interventions that can reduce the detrimental effects of prolonged hematomas or elevated intracranial pressures. Moreover, it also emphasizes how knowledge of the correlation between nonmodifiable factors like the size of haemorrhage and location suggests that personalized medicine should be used to identify the most appropriate procedure for patients [25].

CONCLUSIONS

This study emphasizes the position of early identification and risk social stratification in patients with ICH. Effective management approaches, as well as strict blood pressure control, early neurosurgical evaluation, and personalized rehabilitation plans, can significantly improve patient outcomes. Including progressive imaging methods and biomarker evaluations in clinical protocols may additionally improve predictive accuracy and treatment effectiveness. Future investigations should focus on potential studies and precision medicine methods to refine treatment strategies and advance survival rates in ICH patients.

CONTRIBUTION OF AUTHORS

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