ORIGINAL ARTICLE

Unveiling the Crystal Ball: Predictors of Adverse Outcomes in Intracerebral Hemorrhage Patients

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Abstract

Introduction: Intracerebral hemorrhage (ICH) is a severe form of stroke with substantial morbidity and mortality worldwide. Despite its impact, research has often focused on ischemic strokes, making ICH an essential area to explore.

Methods: A retrospective cohort study spanning 5 years was conducted in an Oman-based tertiary care teaching hospital's emergency room. Data from patients diagnosed with spontaneous ICH, confirmed by cranial CT scans, were analyzed. Ethical approval was obtained.

Results: Among 163 emergency room (ER)-presented patients with ICH, 89 met the inclusion criteria. Most were male (69.66%), with hypertension (69/89) and diabetes mellitus (43/89) being common comorbidities. Hematoma size was a crucial predictor of poor outcomes, especially for larger hematomas (>60 cm^3). Midline shift, intraventricular hemorrhages, elevated systolic and diastolic blood pressure, and low Glasgow Coma Scale (GCS) scores were significantly associated with unfavorable outcomes. However, variables such as age, gender, history of heart disease, hypertension, diabetes, and anticoagulant use did not show significant associations with disability outcomes. Favorable outcomes (mRS <3) were observed in 47.2% of patients, while 30.3% had a major disability (mRS 3–5), and 22.5% succumbed to their illness (mRS 6).

Conclusion: This study enhances our understanding of ICH outcomes, highlighting the importance of hematoma size, midline shift, intraventricular hemorrhage, blood pressure control, and GCS scores in predicting disability. Future research could explore additional prognostic factors and interventions for ICH patients.

Keywords: Cerebrovascular accident, Emergency room, Intracerebral hemorrhage, Poor outcome, Stroke.

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Highlights

The study underscores the importance of demographic, clinical, radiological, and laboratory factors in predicting outcomes for intracerebral hemorrhage patients. Key predictors of poor outcomes include blood pressure, Glasgow Coma Scale (GCS) score, hematoma size, and midline shift. Despite challenges, a considerable number of patients achieve favorable outcomes, highlighting the potential for recovery.

Introduction

Intracerebral hemorrhage (ICH) represents a formidable challenge within the fields of neurology and emergency medicine (EM). This devastating form of stroke, characterized by bleeding within the brain's parenchyma, often strikes suddenly, leaving behind a wake of neurological devastation and substantial morbidity and mortality risks.[1–3] The global burden of ICH is substantial, with its incidence varying among different regions and populations. Annually, an estimated 24.6 cases per 100,000 individuals suffer from ICH, making it less common than ischemic strokes but equally devastating.[3,4] While stroke research has predominantly focused on ischemic strokes, it is imperative not to overlook ICH, as it accounts for a disproportionate share of stroke-related mortality and morbidity.

The Silent Intruder: Understanding Intracerebral Hemorrhage

Intracerebral hemorrhage often referred to as "brain bleeding", represents a type of stroke characterized by the rupture of small arteries or arterioles within the brain tissue itself.[5,6] Unlike ischemic strokes, which result from blocked blood vessels, ICH originates from spontaneous bleeding, leading to the formation of a hematoma and immediate neurological consequences.[5,6]

Demographic and Clinical Predictors: Unveiling the Human Factor

Demographic factors, such as age and gender, have long been recognized as critical elements in predicting the outcomes of patients with ICH. Elderly individuals face a higher risk of ICH, often compounded by comorbidities, making them particularly susceptible to adverse outcomes.[7–9] Furthermore, gender differences in ICH incidence and outcomes have been observed, with males having a higher risk of ICH but females facing a worse prognosis once affected.[10–12]

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Clinical factors further compound the intricate landscape of ICH prognosis. The initial neurological status of a patient upon presentation can be a powerful predictor of outcomes. The Glasgow Coma Scale (GCS) and the National Institutes of Health Stroke Scale (NIHSS) serve as invaluable tools, providing insight into the severity of neurological deficits and guiding early treatment decisions. Comorbidities, such as hypertension, diabetes, and heart disease, significantly influence outcomes, emphasizing the need for comprehensive patient assessments that extend beyond the immediate neurological presentation.[2,6,9]

Radiological and Laboratory Predictors: Peering into the Brain's Secrets

The journey into the world of ICH outcomes is not complete without peering into the intricate web of radiological and laboratory predictors. Advanced imaging techniques, particularly computed tomography (CT) and magnetic resonance imaging (MRI), have revolutionized our ability to diagnose and prognosticate ICH. The location, size, and growth patterns of the hematoma within the brain hold critical clues to the patient's fate.[13–16] Deep-seated hemorrhage, those with greater volume, and those exhibiting significant expansion over time are often associated with poorer outcomes.[17] In addition to radiological factors, laboratory markers offer a window into the systemic response to ICH. Hematologic parameters such as hemoglobin levels, platelet counts, and coagulation profiles can aid in predicting the risk of hematoma expansion and rebleeding.[18,19] Elevated blood glucose levels on admission have been linked to worse outcomes, highlighting the intricate relationship between metabolic factors and ICH progression.[20,21]

Championing the Cause: Emergency Management and Beyond

Effective management of ICH begins in the emergency room (ER), where time-sensitive decisions can significantly influence patient outcomes. A thorough neurological assessment, complemented by imaging studies, is vital for accurate diagnosis and treatment planning.[12,22] Blood pressure control, reversal of anticoagulation therapy when indicated, and surgical interventions in select cases are all critical components of early management.[12]

Facing the Uncertainty: Predictors of Poor Outcomes

The journey of an individual diagnosed with ICH is often fraught with uncertainty. Outcomes can vary dramatically, ranging from full recovery to profound disability or even death. Predicting these outcomes is not straightforward, but several factors have been associated with poorer prognoses.[3,5,6,9] The size and location of the hematoma, the patient's age, the severity of neurological deficits at presentation, and the presence of comorbidities, such as diabetes or heart disease, all play a significant role. Identifying these predictors is crucial for healthcare providers, as they guide treatment decisions, set realistic expectations, and inform rehabilitation efforts.

The ability to predict adverse outcomes in ICH patients is not only a scientific pursuit but also a clinical imperative. At the heart of precision medicine, a burgeoning field in healthcare, this retrospective observational study from a prominent ER in Muscat, Oman, will comprehensively explore predictors, revealing the latest insights from research and clinical practice, and further contributing to the existing medical literature.

Methods

Study Design

This retrospective cohort study was conducted within the ER of a tertiary care teaching hospital situated in Muscat, Oman. Our ER is equipped with 2 resuscitation beds, 4 bay beds designated for critical cases, 12 cubicle beds for moderately ill patients, and 4 triage beds, totaling 22 operational beds. The average bed occupancy rate consistently maintains an 88% level, with fluctuations observed throughout the day. Our ER is an integral part of a tertiary, educational, and training hospital, serving an annual influx of approximately 60,000 patients or more, encompassing various medical, surgical, toxicological, and pediatric cases. Notably, our ER holds accreditation and has received the esteemed Platinum-level recognition from Accreditation Canada International.

Study Period and Participants

The study was extended over a 5-year duration, commencing on January 1st, 2013, and concluding on January 1st, 2018. It encompassed all individuals who presented to the ER during this timeframe with confirmed spontaneous ICH, as evidenced by cranial CT scans. To uphold the precision and reliability of the data, individuals with incomplete or missing medical records were methodically omitted from the study. Furthermore, patients under the age of 18, those with subarachnoid or subdural hemorrhage, and individuals with ICH resulting from factors such as tumors, trauma, vasculitis, arteriovenous malformations, or aneurysm rupture (CT angiogram or digital subtraction angiogram positive cases) were also excluded from the study.

ER Management and Disposition

Each patient underwent a comprehensive examination and evaluation in the ER. Subsequently, emergency treatment was promptly initiated based on their hemodynamic parameters, encompassing the fundamental components of emergency medicine known as the "ABC" – comprising airway, breathing, and circulation management. Our goal was to lower blood pressure gradually while monitoring neurological status and maintaining cerebral perfusion pressure within an appropriate range, given that elevated blood pressure is a recognized adverse effect in the progression of ICH. We used one or multiple antihypertensive drugs and included labetalol infusion when blood pressure remained above 140/90 mm Hg, tailoring our approach for comprehensive blood pressure control. The decision of reversal of anticoagulation was carefully considered, tailored to each patient's condition, and implemented when necessary, particularly in cases of severe or life-threatening bleeding, utilizing reversal agents or blood products such as fresh frozen plasma, prothrombin complex concentrates, or platelets as dictated by the clinical context. Following initial stabilization, they underwent neuroimaging before consulting the on-call neurosurgeon. The decision to admit patients to the intensive care unit (ICU) or proceed to the operating room (OR) was determined by the neurosurgeon's evaluation.

Degree of Disability Assessment

The Modified Rankin Scale (mRS) serves as a key instrument for evaluating the degree of disability in individuals who have experienced a stroke. It stands as one of the most widely utilized and validated tools for assessing clinical outcomes in such cases. This scale operates on a continuum spanning from 0 to 6, ranging

from a state of complete health with no discernible symptoms to fatality. Within the scope of our research, we categorized the scale into three distinct groups: the "Independent" or "Minor Disability" group (scores <3), the "Dependent" or "Major Disability" group (scores 3–5), and the "Mortality" group (score = 6).[23,24]

Variables

The study involved a meticulous review of the patient's medical records, which included the completion of a comprehensive study form to document essential information, such as medical history, clinical observations, and relevant laboratory or radiological investigations. Several variables were considered, including age, gender, blood pressure, blood sugar levels, GCS, past medical history (including ischemic heart diseases), and the use of antiplatelet or anticoagulant medications. The variables examined in this study encompassed radiographical aspects, including the location, midline shift, hematoma size, perihematomal edema, hydrocephalus, and intraventricular hemorrhage. Additionally, laboratory test results such as serum fibrinogen level, platelet count, and coagulopathy were included. Due to insufficient data about patients with alcohol abuse and smoking habits, they were excluded from our data analysis. Neurological outcomes were assessed by dividing the modified Rankin scale into two groups: those with minor disability (mRS <3) and those with major disability (mRS 3–5), while a score of 6 indicated mortality, as detailed above.

Data Collection and Statistical Analysis

Data were retrieved from the hospital's electronic database (TrakCare 2018: Maintenance release: R6. SQUH.ADHOC6 Build #7) and analysed using Statistical Package for the Social Sciences (IBM® SPSS®) software version 23.0, developed in Armonk, New York, USA. Continuous variables were summarized with mean and standard deviation to provide insights into central tendency and spread. Categorical variables were summarized with frequencies and percentages to present the distribution within our study cohort. Additionally, we conducted bivariate logistic regression analysis to assess the relationship between these variables, calculating *p*-values, and considering significance at a level below 0.05.

Ethical Considerations

Prior to initiating this study, we obtained ethical approval (Reference no: SQU-EC/118/18; MREC #1738, dated 29th August, 2018) from the Institutional Review Board (IRB). Given the retrospective nature of our research, the IRB granted a consent waiver. Patient confidentiality and data security were safeguarded through the use of unique identifiers to anonymize patient data and password-protected data entry software accessible only to authorized personnel. These measures were diligently enacted to uphold patient privacy and comply with data protection regulations during the study.

Results

During the specified period, a total of 163 patients presented to the ER with ICH, but our study's inclusion criteria led to the inclusion of only 89 patients. The study population had a mean age of 52.88 (SD: 12.8) years, with a majority of male patients (69.7%). Gender and age classifications are detailed in Table 1. The most prevalent comorbidities were hypertension (69/89), diabetes mellitus (43/89), and ischemic heart disease necessitating single or dual antiplatelet drugs (35/89). Five patients were on oral anticoagulation (Warfarin), and one was receiving rivaroxaban for their underlying cardiac condition. Table 1 displays clinical presentations, vital signs,

Table 1: Age, gender-wise distribution, clinical presentations, vital signs, neurological examination, and CT scan findings at presentation to the emergency room

Variables	*Frequency 89 (%)*
Age (SD*) years	52.88 (SD: 12.8)
Male gender	62 (69.7)
Female gender	27 (30.3)
Age-groups	
18–49 years	23 (25.8)
50–69 years	40 (44.9)
>70 years	26 (29.2)
Most common clinical presentations (usually more than one symptom)	
Unilateral limb weakness	52 (58.4)
Ataxia	9 (10.1)
Severe sudden onset headache	25 (28.1)
Decrease or altered sensorium	46 (51.7)
Involuntary movements – seizure-like activity	2 (2.3)
Nausea/vomiting	55 (61.8)
Vital signs at presentation to the emergency room	
Systolic blood pressure ≥180 mm Hg	26 (29.2)
Diastolic blood pressure ≥120 mm Hg	14 (15.7)
Pulse rate (IQR$)	66 (78, 112)
Respiratory rate ≥22/minute	35 (39.3)
O_2 saturation <88% in room air	31 (34.8)
High random blood glucose level (> 12.1 mmol/L)	21 (23.6)
Neurological examination based on the Glasgow Coma Scale (GCS)	
GCS: 11–15	54 (60.7)
GCS: 8–10	13 (14.6)
GCS <8	22 (24.7)
Tongue fall/noisy breathing/grunting	25 (28.1)
Plain computed tomography (CT) scan brain findings (at presentation)	
Location of hematoma (predominant area of involvement)	
Lobar hematoma	32 (35.9)
Basal ganglia hematoma	49 (55.1)
Pontine hematoma	4 (4.5)
Cerebellar hematoma	4 (4.5)
Size of hematoma (cm^3)	
<30 cm^3	67 (75.3)
30–59 cm^3	9 (10.1)
>60 cm^3	13 (14.6)
Midline shift	31 (34.8)
Perihematomal edema	69 (77.5)
Intraventricular hemorrhage	28 (31.5)
Obstructive hydrocephalus	7 (7.9)

SD*, standard deviation; IQR$, interquartile range

Table 2: Correlation between age-groups, gender, past medical history, and vital signs at presentation to the emergency room versus degrees of disabilities

Variables	*mRS* Minor disabilities (<3) n = 42 (47.2%)*	*mRS* Major disabilities (3–5) n = 27 (30.3%)*	*mRS* Mortality (6) n = 20 (22.5%)*	*p-value*
Age-group – 18–49 years	13 (30.9)	4 (14.8)	6 (30.0)	0.416
Age-group – 50–69 years	18 (42.9)	12 (44.4)	10 (50.0)	
Age-group – 70 years or more	11 (26.2)	11 (40.8)	4 (20.0)	
Male gender	30 (71.4)	18 (66.7)	14 (60.0)	0.125
Female gender	12 (28.6)	9 (33.3)	6 (40.0)	
Past medical history (one or more)				
Essential hypertension	34 (80.9)	20 (74.1)	15 (75.0)	0.188
Diabetes mellitus	20 (47.6)	13 (48.2)	10 (50.0)	0.729
Ischemic heart disease requiring antiplatelet therapy	27 (64.3)	4 (14.8)	4 (20.0)	0.104
Requiring oral anticoagulation for an underlying medical condition	3 (7.2)	2 (7.4)	1 (5.0)	0.725
Others#	4 (9.5)	2 (7.4)	2 (10.0)	0.521
Vital signs at presentation and neurological status (Glasgow Coma Score: GCS) to the emergency room				
High systolic blood pressure (≥180 mm Hg)	5 (11.9)	9 (33.3)	12 (60.0)	<0.001
High diastolic blood pressure (≥120 mm Hg)	0	1 (3.7)	13 (65.0)	<0.001
High random blood glucose level (>12.1 mmol/L)	7 (16.7)	7 (25.9)	7 (35.0)	0.349
GCS: 11–15	36 (85.7)	13 (48.2)	5 (25.0)	<0.001
GCS: 8–10	4 (9.5)	7 (25.9)	2 (10.0)	
GCS <8	2 (4.8)	7 (25.9)	13 (65.0)	

mRS*, modified Rankin Scale; Others#, chronic kidney disease, chronic liver disease, reactive airway disease; *p*-values were calculated for the comparison between mRS <3 (minor disabilities) and mRS 3–5 (major disabilities) in terms of the degree of disabilities

neurological examinations, and random blood sugar levels upon ER presentation.

Table 1 provides frequencies and percentages of radiological findings among the ICH patients in this study. Among the patients, 49 out of 89 had basal ganglia hematomas, while 32 had lobar hematomas. The size of the hematoma was <30 cm^3 in 67 (75.3%) patients. Of the total, 31 (34.8%) patients had midline shifts, 69 (77.5%) exhibited perihematomal edema, and 28 (31.5%) had intraventricular hemorrhages.

Table 2 illustrates a comprehensive representation of the degree of disability at discharge, categorized by age-group, gender, medical history, vital signs at presentation, random blood sugar levels at presentation, and GCS, all in conjunction with their respective univariate logistic regression analyses. This analysis revealed a significant correlation between poor outcomes in patients presenting with high systolic blood pressure (> 180 mm Hg), elevated diastolic blood pressure (>120 mm Hg), and low GCS (<8). However, no significant associations were found between mRS and other variables such as age, gender, history of heart disease, hypertension, diabetes, or the use of anticoagulant medications.

Table 3 illustrates disability levels concerning to hematoma location. While 65% of patients in the mortality group had basal ganglia hematoma, a matching 64% were found in the minor disability group, indicating no significant association between hematoma location and outcome severity (*p*-value = 0.463). However, a noteworthy connection existed between hematoma size and disability degree. Patients succumbing to their illness had a larger hematoma size (>60 cm^3) in 55% of cases, contrasting with the major (3.7%) and minor (2.4%) disability groups (*p*-value <0.001). Logistic regression analysis further highlighted the significance of midline shift in predicting poor outcomes (*p*-value = 0.002). On the other hand, statistical analysis revealed no significant relationships between disability levels at discharge and parameters like perihematomal edema (*p*-value = 0.064) or hydrocephalus (*p*-value = 0.089). Table 3 also presents the correlation between disability levels and laboratory investigations, where no significant relationships were observed.

Upon hospital discharge, the majority of our patients, constituting 42 individuals (47.2%), achieved favorable outcomes with an mRS score of <3. Conversely, 27 patients (30.3%) experienced less favorable outcomes, falling within the mRS range of 3–5. The death group comprised 20 out of the 89 ICH patients (22.47%), all of whom had an mRS score of 6.

Discussion

The outcomes of our study, conducted over 5 years in the ER, offer valuable insights into the clinical profile and outcomes of patients with ICH. These findings both resonate with existing literature and introduce unique observations, contributing to the expanding body of knowledge on outcomes of patients with ICH.

The prevalence of comorbidities observed in this study aligns with established risk factors for ICH. Hypertension, a leading risk factor, was present in a significant portion of the patients, consistent with previous research.[25,26] Ischemic heart disease, which often involves the use of antiplatelet medications, was also highly prevalent. These comorbidities underline the complex medical backgrounds of ICH patients, which can influence treatment decisions and outcomes. The presence of patients on oral anticoagulants like warfarin and rivaroxaban highlights the challenges of managing ICH in individuals with coagulation disorders.[1,27,28] Managing anticoagulated ICH patients is a topic of

Table 3: Correlation between neuroimaging and laboratory findings and degrees of disabilities

Variables	*mRS* Minor disabilities (<3) n = 42 (47.2%)*	*mRS* Major disabilities (3–5) n = 27 (30.3%)*	*mRS* Mortality (6) n = 20 (22.5%)*	*p-value*
Correlation between plain computed tomography (CT) scan brain findings and degree of disabilities				
Location of hematoma				
Lobar hematoma	14 (33.3)	17 (63.0)	1 (5.0)	0.463
Basal ganglia hematoma	27 (64.3)	9 (33.3)	13 (65.0)	
Pontine hematoma	1 (2.4)	0	3 (15.0)	
Cerebellar hematoma	0	1 (3.7)	3 (15.0)	
Size of hematoma (cm^3)				
<30 cm^3	41 (97.6)	23 (85.2)	3 (15.0)	<0.001
30–59 cm^3	0	3 (11.1)	6 (30.0)	
>60 cm^3	1 (2.4)	1 (3.7)	11 (55.0)	
Midline shift	7 (16.7)	12 (44.5)	12 (60.0)	0.002
Perihematomal edema	28 (66.7)	24 (88.9)	17 (85.0)	0.064
Intraventricular hemorrhage	6 (14.3)	9 (33.3)	13 (65.0)	0.002
Obstructive hydrocephalus	1 (2.4)	2 (7.4)	4 (25.0)	0.089
Correlation between laboratory findings and degree of disabilities				
Platelet counts: normal (>150 × 10^9/L)	35 (83.3)	25 (92.6)	18 (90.0)	0.319
Platelet counts: low (125–149 × 10^9/L)	2 (4.8)	2 (7.4)	0	
Platelet counts: very low (<125 × 10^9/L)	5 (11.9)	0	2 (10.0)	
Serum fibrinogen levels: normal (<3.6 gm/L)	22 (52.4)	13 (48.1)	9 (45.0)	0.889
Serum fibrinogen levels: high (3.6–5.5 gm/L)	16 (38.1)	11 (40.8)	10 (50.0)	
Serum fibrinogen levels: very high (>5.5 gm/L)	4 (9.5)	3 (11.1)	1 (5.0)	
International normalized ratio (INR) normal (<2)	41 (97.6)	27 (100)	20 (100.0)	0.568
International normalized ratio (INR) high (>2)	1 (2.4)	0	0	

mRS*, modified Rankin Scale; Others#, chronic kidney disease, chronic liver disease, reactive airway disease; *p*-values were calculated for the comparison between mRS <3 (minor disabilities) and mRS 3–5 (major disabilities) in terms of the degree of disabilities

ongoing research, as it poses unique therapeutic dilemmas.[28–30] Such cases require careful evaluation and may necessitate interventions to reverse anticoagulation.

Table 3 provides insights into the relationship between disability levels and hematoma characteristics. While no significant association was found between hematoma location and outcome severity, hematoma size emerged as a significant predictor of poor outcomes, consistent with previous research.[17] The prognostic value of midline shift, as highlighted in our analysis, aligns with earlier studies, underscoring the importance of radiological assessments in predicting ICH outcomes. Notably, hematoma size was a critical determinant of outcomes, particularly larger hematomas, exceeding 60 cm^3, which were associated with a poorer prognosis.[31–33] This finding corroborates the extensive body of literature emphasizing the prognostic significance of hematoma volume expansion in ICH patients. Furthermore, the absence of significant associations between disability levels and parameters like perihematomal edema or hydrocephalus echoes previous findings, indicating that these factors might not be independent predictors of outcomes.[34,35]

The correlation analysis involving clinical parameters and disability outcomes provided valuable insights. Elevated systolic and diastolic blood pressure levels, as well as low GCS scores, were significantly associated with unfavorable outcomes. This aligns with prior research emphasizing the role of blood pressure control and neurological status in predicting ICH severity.[9,25,26]

However, it is notable that our study did not find significant associations between disability outcomes and several other variables, including age, gender, history of heart disease, hypertension, diabetes, or the use of anticoagulant medications. While these results may differ from some previous research, they highlight the complex and multifactorial nature of ICH outcomes, suggesting that individual patient characteristics and comorbidities may interact in nuanced ways. Our study's results at hospital discharge, detailed in (Fig. 1), indicate that a considerable portion of patients attains favorable outcomes, aligning with findings from comparable studies.[7] This observation emphasizes the potential for recovery among ICH patients, even when faced with significant initial clinical difficulties. Nevertheless, the substantial proportion of patients encountering less favorable outcomes or mortality underscores the persistent challenges associated with the management of this intricate medical condition.

Implications and Future Directions

Our findings contribute to the understanding of factors influencing disability outcomes in ICH patients, emphasizing the importance of timely evaluation and management, particularly in cases with high blood pressure and midline shift. The inclusion of a relatively large sample size and comprehensive assessment of variables strengthens the validity of our results.

Future research in this field could explore additional prognostic factors and interventions aimed at improving outcomes in ICH patients. Moreover, prospective studies may provide further insights into the dynamic nature of ICH and its long-term consequences on patient disability and quality of life.

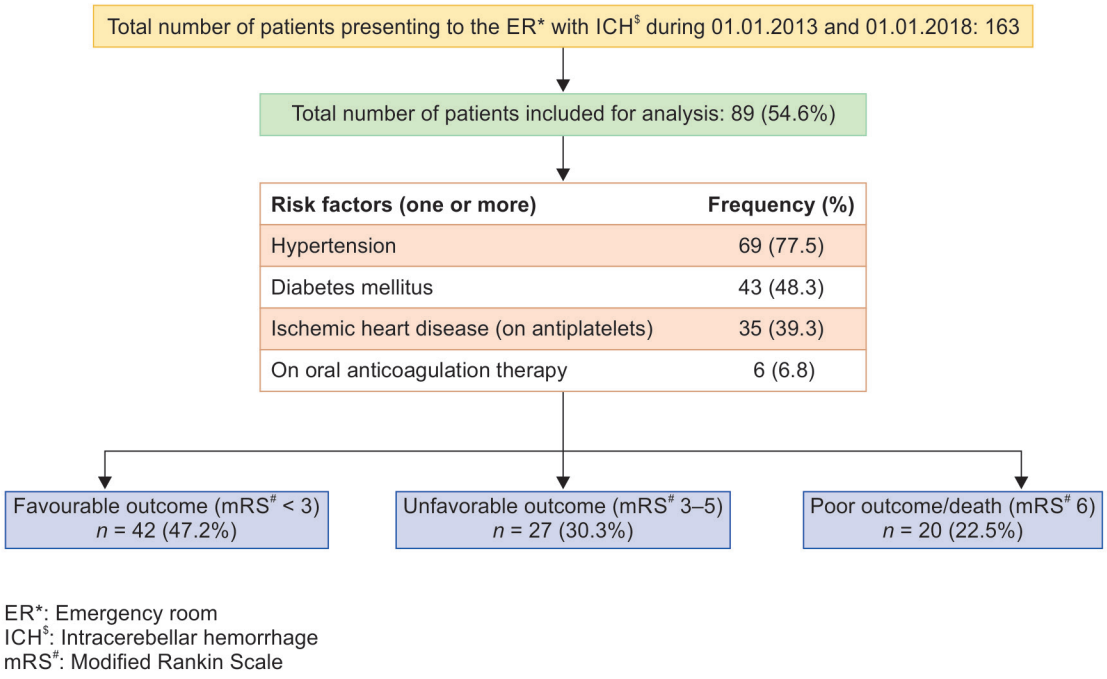

Fig. 1: Strengthening the reporting of observational studies in epidemiology (STROBE) statement

Limitations

Several limitations were encountered in our study. One notable challenge was our reliance on medical records, which proved to be inconsistent in terms of data maintenance. This inconsistency led to the exclusion of certain data points from our study, potentially affecting the comprehensiveness of our analysis. Additionally, it is essential to recognize that our study was primarily conducted in the ER, with the primary objective of identifying predictors of adverse outcomes in intracerebral hemorrhage patients. As a result, we did not explore the intricacies of neurosurgical interventions, including critical information such as the number of patients offered these treatments or the precise timing of surgical procedures.

Conclusion

This study contributes to the existing literature on ICH by providing insights into the clinical characteristics and outcomes of patients in our specific setting. Our findings align with many established associations, such as the link between hypertension and ICH, and reinforce the prognostic significance of hematoma size. However, some results, such as the lack of significant associations with certain variables, warrant further exploration and comparison with larger, more diverse patient populations to enhance our understanding of ICH. Our study's insights may assist healthcare providers in risk assessment and treatment planning for ICH patients and provide a foundation for future research in this critical area of neurology and emergency medicine.

Quality of Research and Ethical Declaration

The research conducted in this study received approval from the Institutional Review Board/Ethics Committee at Sultan Qaboos University Hospital in Muscat, Sultanate of Oman, under the reference numbers SQU-EC/118/18; MREC #1738, with an approval date of 29th August, 2018. Throughout this research project, the authors adhered to the relevant EQUATOR Network (http://www.equator-network.org/) guidelines, specifically following the STROBE guidelines. Furthermore, we affirm that the contents of this submission are original, and we have conducted a thorough plagiarism check to ensure their authenticity.

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