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Original Article

Internal Medicine Section

Utility of Intracranial Haemorrhage Score in Non Traumatic Intracranial Haemorrhage- A Longitudinal Study

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ABSTRACT

Introduction: Intracranial Haemorrhage (ICH) is any bleeding that occurs inside the intracranial vault, which includes the brain parenchyma and the surrounding meningeal spaces. It is a devastating illness associated with significant morbidity and mortality. The ICH score was developed in 2001 as a predictive tool for mortality. It is a six point score based on five components i.e, age, ICH volume, Intraventricular Haemorrhage (IVH), site of bleed and Glasgow Coma Scale (GCS).

Aim: To study the utility of ICH score for predicting 30 day mortality and morbidity and also to determine if ICH calculated 24 hours after admission is a better indicator of mortality.

Materials and Methods: This was a longitudinal observational study conducted among 235 patients, with spontaneous ICH, who were admitted in the Department of General Medicine, Government Medical College, Kozhikode, Kerala, India, from January 2019 to December 2019. Data collected included risk factors, clinical features and Glasgow Coma Scale (GCS), and Computed Tomography (CT) findings. The ICH score was calculated at the time of presentation and after 24 hours. Functional status of the patients were assessed using modified Rankin Scale (mRS) on day 30 of the illness. Chi-square test was used to analyse categorical variables. Odds ratio was calculated. Relation between ICH score and mRS on day 30 was analysed using logistic regression. A p-value <0.05 was taken as statistically significant.

Results: The mean age of the study population was 61.52±12.67 years. Overall, 136 (57.9%) patients were males. Prevalence of hypertension, diabetes mellitus, dyslipidemia, and alcohol abuse were 85.5%, 34%, 31.9% and 17%, respectively. There were 60 deaths (25.5%). All components of ICH score i.e, age (OR=5.39), GCS (OR=488.65), ICH volume (OR=5.519), IVH (OR=29.08), and site of ICH (OR=18.32) as well as newer parameters, like, the presence of hydrocephalus (OR=18.32), midline shift (OR=7.49) and anisocoria (OR=12.25) were significant predictors of mortality (p-value <0.05). Hemiplegia (177, 75.3%) was the most common, and seizure (24, 10.2%) was the least common presentation. Mortality rate was higher in those with higher ICH scores (100% for scores 4 and 5, and 79.3% for score 3). Receiver Operating Characteristic (ROC) curve with ICH score of 3 as cut-off predicted outcome with an accuracy of 94.9% (90% sensitivity and 96.6% specificity).

Conclusion: Intracranial haemorrhage score is a practical tool in predicting patient outcome in patients with ICH. The ICH score calculated after 24 hours was observed not to be superior to that calculated at the time of admission.

Keywords: Hemiplegia, Modified Rankin scale, Mortality, Outcome

INTRODUCTION

Intracranial Haemorrhage (ICH) accounts for approximately 10 to 20% of all strokes [1]. It is a devastating illness associated with significant morbidity and mortality. The 30 day mortality ranges between 32% to 50% [2]. Approximately half of the deaths occur within the first 24 hours of onset [3]. ICH is associated with significant patient and healthcare associated costs and resource utilisation [4].

Despite advances in the field of medical and neurosurgical treatment, ICH still remains an illness with poor outcome [5]. The risk factors for ICH in developing nations are usually similar to those in developed countries, but the outcome and prognosis are poor because compliance with treatment for control of risk factors is below par [6]. So, there is a higher incidence of ICH in countries like India in comparison to western population [7]. In a study from Southern India, 30 out of 50 patients succumbed to ICH with 66.67% (n=20) of deaths occurring in the first 24 hours [5]. In another study from Northern India, 48 (40%) out of 120 patients with ICH died [8].

Considering the poor outcome of ICH, numerous scoring systems have been developed to optimise patient management, similar to the Hunt and Hess score in Subarachnoid Haemorrhage [9] and National Institute of Health Stroke Scale (NIHSS) in ischaemic stroke [10]. The ICH score was developed by Hemphill III JC et al., as a tool for predicting mortality at 30 days after haemorrhagic stroke [11]. The ICH score is a 6-point calculation based on five clinical parameters i.e, age >80 years, Glasgow Coma Scale (GCS), volume of haematoma on Computed Tomography (CT) scan, location (infratentorial or supratentorial) and the presence of intraventricular extension [Table/Fig-1] [11]. It is a clinical tool that can be rapidly and accurately assessed at the time of presentation by any personnel who need not be necessarily trained in neuroimaging. Prognostication is undoubtedly important to assess treatment benefits and risks and also provides information regarding disease severity.

Various studies done have shown association between ICH score and functional outcome similar to the original study conducted by Hemphill III JC et al., [11-13]. Similar results were also observed in an Indian study by Ojha P et al., [8]. The purpose of this study was to validate the ICH score for prediction of mortality as well as morbidity as there is paucity of studies on its utility in the Indian population. The study has also determined if the ICH score calculated after 24 hours is a better predictor of outcome than the score at presentation.

MATERIALS AND METHODS

This longitudinal observational study was conducted in the Department of General Medicine, Government Medical College, Kozhikode, Kerala, India, from January 2019 to December 2019. The study was approved by Institutional Ethics Committee (IEC number GMCKKD/RP2019/IEC/121).

Component of ICH score	Point
Glasgow coma score	
3-4	2
5-12	1
13-15	0
ICH volume	
≥30 mL	1
<30 mL	0
Intraventricular haemorrhage	
Yes	1
No	0
Site of bleed	
Infratentorial	1
Supratentorial	0
Age	
≥80 years	1
<80 years	0
Total score	0-6

[Table/Fig-1]: Components of ICH score.

Sample size calculation: Sample size was calculated using the formula: $n=4pq/d^2$ where;

p=prevalence,

q=100-p,

d=permissible error.

With a prevalence of 30% [14], a permissible error of 20%, the sample size calculated was 233. Finally, 235 patients with ICH were included in the study.

Inclusion criteria: Patients above the age of 18 years admitted with non traumatic ICH as diagnosed through a CT scan were included in the study.

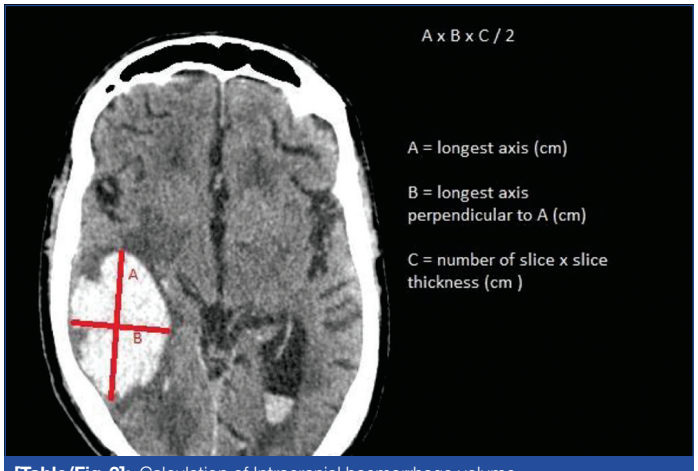
Exclusion criteria: Recurrent intracranial haemorrhage, arteriovenous malformations, primary non parenchymal bleed, traumatic ICH, haemorrhagic infarction and those on anticoagulant or antiplatelet therapy were excluded from the study.

Procedure

Consent was obtained from the patients' relatives. Risk factors, clinical features at presentation, GCS at presentation and after 24 hours and CT findings were recorded. Alcoholics were defined using the Cut, Annoyed, Guilty and Eye (CAGE) questionnaire [15].

The ICH volume, site of ICH, presence or absence of IVH, hydrocephalus and midline shift were noted. The ICH volume was calculated using the formula [Table/Fig-2] [11]:

ABC/2, where A is the greatest diameter of the haematoma on the slice with the largest diameter, B is the diameter of the hematoma in the axis perpendicular to A, and C is the number of axial slices in which the haematoma is visible, multiplied by the slice thickness. The ICH scores were calculated at presentation and after 24 hours. Modified Rankin Scale (mRS) was used to assess functional outcome and mortality on day 30 of illness [Table/Fig-3] [16].



[Table/Fig-2]: Calculation of Intracranial haemorrhage volume.

Scale	Description
0	No symptoms
1	No significant disability. Able to carry out all usual activities, despite some symptoms
2	Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities
3	Moderate disability. Requires some help, but able to walk unassisted
4	Moderately severe disability. Unable to attend to own bodily needs without assistance and unable to walk unassisted
5	Severe disability. Requires constant nursing care and attention, bedridden, incontinent
6	Dead

[Table/Fig-3]: Modified Rankin Scale.

STATISTICAL ANALYSIS

The data was analysed using Statistical Package for Social Sciences (SPSS) software after entering Microsoft Excel. Chi-square test was used to analyse categorical variables. Odds ratio was calculated for risk factors. Relation between ICH score and mRS on day 30 was analysed using logistic regression. A p-value <0.05 was taken as statistically significant.

RESULTS

Out of 235 patients, there were 136 males (57.9%) and 99 females (42.1%). The mean age was 61.52±12.67 years. Hemiplegia (75.3%) was the most common presentation, followed by headache (40%) [Table/Fig-4]. The site of ICH in these patients are shown in [Table/Fig-4]. [Table/Fig-5a-d] shows CT images of various ICH. [Table/Fig-6,7] show analysis of risk factors and clinical features as mortality predictors.

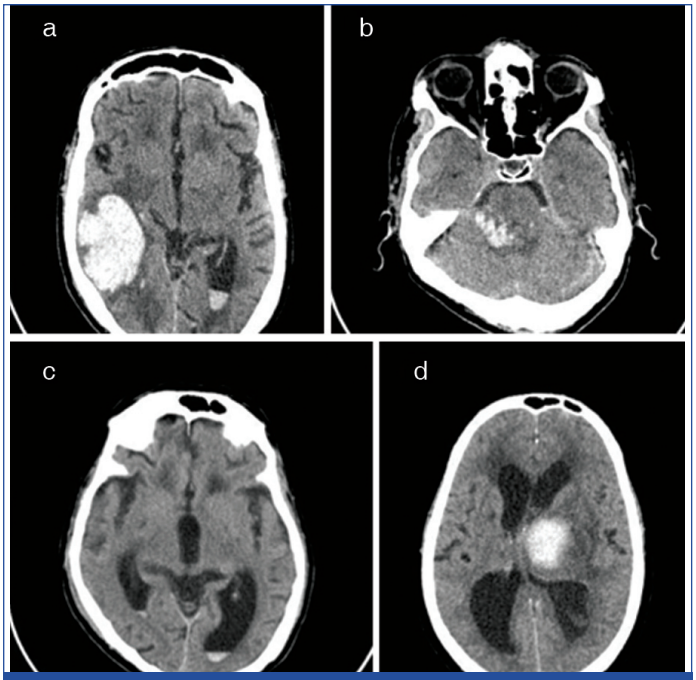
Site of ICH	n (%)	Symptoms	n (%)
Gangliocapsular region	172 (73.2%)	Hemiplegia	177 (75.3%)
Brainstem	17 (7.2%)	Seizure	24 (10.2%)
Cerebellum	5 (2.1%)	Loss of consciousness	67 (28.5%)
Lobar bleed	41 (17.44%)	Headache	94 (40%)
		Vomiting	65 (27.7%)

[Table/Fig-4]: Sites and symptoms of ICH.

Certain new parameters which are clinically relevant were analysed. They include hydrocephalus, midline shift, anisocoria and bradycardia [Table/Fig-7]. Univariate analysis using logistic regression showed all components of ICH as significant predictors of mortality but multivariate showed only GCS as significant (p-value <0.001).

Higher the ICH scores, greater was the mortality rate [Table/Fig-8, 9]. Scores 4 and 5 were associated with 100% mortality, when calculated at the time of admission, as well as after 24 hours. There were no patients with a score of 6 in the population. Receiver Operator Characteristics curve was used to assess the utility of ICH score in predicting mortality. The cut-off value of 3 was used as the area under the curve was maximum with the same [Table/Fig-10]. ICH score predicted mortality with an accuracy of 94.9% (90% sensitivity and 96.6% specificity.

The mRS was used to assess functional outcome at day 30 of ICH. Higher ICH scores were associated with poorer outcomes. The mRS ≥4 was taken as poor outcome as patients would not be able to walk or carry out daily routine activities without any assistance. Poor outcome was seen in all cases with ICH scores 3,4 and 5.



[Table/Fig-5]: Computed Tomography images showing; a) Right lobar haemorrhage; b) Brainstem haemorrhage; c) Intraventricular haemorrhage; d) Gangliocapsular haemorrhage with midline shift.

Risk factor	Survived (n=175)	Died (n=60)	p-value (Chi-square test)	Odds ratio
Age >80 years	7 (38.9%)	11 (61.1%)	0.001	5.39
Gender (male)	99 (56.6%)	37 (43.4%)	0.490	1.24
Hypertension	152 (75.6%)	49 (24.4%)	0.326	0.67
Diabetes mellitus	54 (67.5%)	26 (32.5%)	0.080	1.75
Dyslipidemia	57 (76%)	18 (24%)	0.712	0.89
Alcohol Use	32 (80%)	8 (20%)	0.380	0.69

[Table/Fig-6]: Analysis of Risk factors as predictors of mortality.
p-value <0.05 was considered as statistically significant

Parameter	Survived	Died	p-value (Chi-square test)	Odds ratio
Intracranial haemorrhage volume >30 mL (n=98)	55 (56.1%)	43 (43.9%)	<0.0001	5.519
Infratentorial bleed (n=22)	4 (18.2%)	18 (81.8%)	<0.0001	18.32
Intraventricular haemorrhage (n=55)	13 (23.6%)	42 (76.4%)	<0.0001	29.08
Glasgow Coma Scale 3-4 (n=35)	0	35 (100%)	<0.0001	488.65
Hydrocephalus (n=22)	4 (18.2%)	18 (81.8%)	<0.0001	18.32
Midline shift (n=91)	47 (51.6%)	44 (48.4%)	<0.0001	7.49
Bradycardia (n=33)	23 (69.7%)	10 (30.3%)	0.4988	1.32
Anisocoria (n=70)	28 (40.0%)	42 (60.0%)	<0.0001	12.25

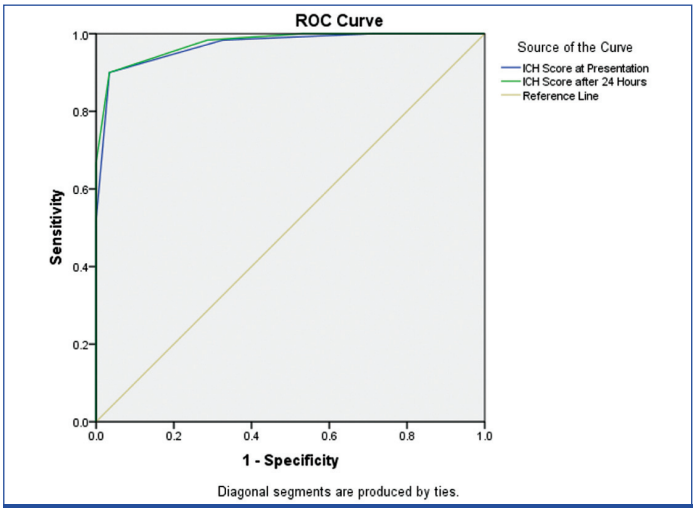
[Table/Fig-7]: Analysis of components of ICH score and other parameters as predictors of mortality.
p-value <0.05 was considered as statistically significant

Intracranial haemorrhage score at admission	Mortality		Total	p-value
	No	Yes		
0	50 (100%)	0	50	<0.001
1	68 (98.6%)	1 (1.4%)	69	
2	51 (91.1%)	5 (8.9%)	56	
3	6 (20.7%)	23 (79.3%)	29	
4	0	17 (100%)	17	
5	0	14 (100%)	14	
Total	175 (74.5%)	60 (25.5%)	235	

[Table/Fig-8]: Association between ICH score at admission and mortality.
p-value <0.05 was considered as statistically significant

ICH score after 24 hours	Mortality		Total	p-value
	No	Yes		
0	82 (100%)	0	82	<0.001
1	43 (97.7%)	1 (2.3%)	44	
2	44 (89.8%)	5 (10.2%)	49	
3	6 (30%)	14 (70%)	20	
4	0	35 (100%)	35	
5	0	5 (100%)	5	
Total	175 (74.5%)	60 (25.5%)	235	

[Table/Fig-9]: Association between ICH score after 24 hours and mortality.
p-value <0.05 was considered as statistically significant



[Table/Fig-10]: Receiver Operator Characteristics Curve for ICH score (at admission and after 24 hours) as a predictor of mortality.

[Table/Fig-11,12] show association between functional outcome and ICH score calculated both at the time of admission and after 24 hours.

Intracranial haemorrhage score at admission	mRS outcome		Total	p-value
	Good	Poor		
0	50 (100%)	0	50	<0.001
1	57 (82.6%)	12 (17.4%)	69	
2	22 (39.3%)	34 (60.7%)	56	
3	0	29 (100%)	29	
4	0	17 (100%)	17	
5	0	14 (100%)	14	
Total	129 (54.9%)	106 (45.1%)	235	

[Table/Fig-11]: Association between ICH score at admission and modified Rankin Scale (mRS).
p-value <0.05 was considered as statistically significant

Intracranial haemorrhage score after 24 hours	mRS outcome		Total	p-value
	Good	Poor		
0	80 (97.6%)	2 (2.4%)	82	<0.001
1	34 (77.3%)	10 (22.7%)	44	
2	15 (30.6%)	34 (69.4%)	49	
3	0	20 (100%)	20	
4	0	35 (100%)	35	
5	0	5 (100%)	5	
Total	129 (54.9%)	106 (45.1%)	235	

[Table/Fig-12]: Association between ICH score after 24 hours and modified Rankin Scale (mRS).
p-value <0.05 was considered as statistically significant

DISCUSSION

Intracranial Haemorrhage (ICH) is a leading cause for significant morbidity and mortality throughout the world. Utility of a clinical

grading score that helps in prognostication can be employed for risk stratification and clinical decision making. Numerous grading scales have been developed to estimate prognosis in patients with ICH [17]. ICH score is one such tool that predicts the functional outcome and moreover it can be rapidly and accurately assessed at the time of presentation even by physicians without special training in stroke neurology.

The objective of the study was to validate the ICH score in predicting functional outcome on day 30 after the onset of illness and to determine if the ICH score calculated after 24 hours was a better indicator of outcome. ICH score was found to be a strong tool in projecting the functional outcome though there was no statistically significant difference between ICH calculated at the time of presentation and after 24 hours in prognostication.

Age more than 80 years was associated with a high mortality of 61.1%. Similar results were obtained in earlier studies [8,11]. Incidence of ICH increases as age advances [18]. This could be attributed to the fact that elderly sustain more severe neurological injury from ICH irrespective of size or location of the bleed. Early withdrawal of aggressive measures in elderly could have also contributed.

Glasgow coma score (GCS) which is used as a routine neurological assessment tool is considered to be the strongest predictor of mortality amongst all the components of ICH score. In the present study as well, GCS of 3-4 was associated with 100% mortality (p-value <0.001, OR=488.65).

Volume of ICH was more than 30 mL in 98 (41.7%) patients, out of which 43 (43.9%) died. It was a significant mortality predictor (p-value <000.1). In a study by Ojha P et al, volume was an independent predictor, although the original study by Hemphill III JC, showed no significant association with mortality [8,11]. This discrepancy could be probably due to the fact that there were more deaths in patients with supratentorial bleeds with larger volumes (80%) in comparison to the original study (43%). The IVH was associated with grave prognosis (76.4% mortality). IVH is related to the volume of ICH as well as location. This is attributed to proximity of ICH to the ventricles and the tendency of blood to spread medially [19]. Hallevi H et al., studied outcome of IV in a study involving 406 patients where 73% had poor outcomes [20].

Infratentorial haemorrhages were associated with very high mortality rate of 81.8%. These haemorrhages though smaller in size were associated with poorer outcome indicating that site rather than volume was more important in infratentorial sites [11]. Hydrocephalus, presence of midline shift and anisocoria were the other factors considered in the study which were independently associated increased morbidity and mortality.

In a study by Aysenne AM et al., 24 hour ICH score was found to be a better predictor of functional outcome [21]. Though the study showed significant association between mortality and ICH scores calculated at the time of presentation as well as after 24 hours, 24 hour ICH score was not found to be superior. It was hypothesised that delayed calculation of ICH score would be more reliable due to the fact that ICH could be complicated by haematoma expansion or new IVH [21].

Modified Rankin Scale (mRS) was used for assessment of functional outcomes including death. Higher ICH score predicted poorer outcomes. Scores above 3 were associated with 100% deaths. Mortality rates were 100% in patients with ICH score more than 4 in previous studies [8,11]. Intracranial haemorrhage score is a simple clinical grading scale for neurological assessment that can be easily and rapidly calculated at the time of presentation. It helps in prognostication to assess treatment benefits and risks and aids in clinical decision making.

Limitation(s)

Blood pressure control and interventional procedures could have affected the outcome. Intracranial haemorrhage score was calculated at the time of presentation to maintain uniformity. Many patients did not present within the first 24 hours of symptom onset. Functional outcome was assessed on day 30 after onset of disease. Recovery of patients may take time. A longer follow-up may provide more accurate view of the functional outcome.

CONCLUSION(S)

Intracranial haemorrhage score is a reliable tool in predicting mortality and functional outcome in patients with ICH. All components of ICH score i.e, age more than 80, GCS, volume of ICH, IVH and site of bleed are independent predictors of mortality and morbidity. Statistically significant newer parameters include hydrocephalus, anisocoria and midline shift. The ICH score helps in risk stratification and clinical decision making. It also aids in prognostication and allows consistency in communication. The ICH score after 24 hours was not found to be superior to the one taken at presentation in predicting outcome. The ICH score should become a standard procedure in patients presenting with ICH and should be used for analysing the functional outcome on follow-up.

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