ORIGINAL ARTICLE

Predicting Functional Neurological Outcome in Haemmorhagic Stroke using Intracerebral Haemorrhage (ICH) score

Brajesh Maurya[1], Lubna Zafar[2]

ABSTRACT

There are numerous evidences for correlation of clinical and radiological parameters with morality in patients with acute haemorrhagic stroke but there is lack of studies in predicting functional outcome. This prospective, observational, cohort study conducted in 100 adult patients of spontaneous intra cerebral haemorrhage. Data pertaining to patients clinical and radiological profile including intracerebral haemmorhage (ICH) score was recorded at admission. After 12 weeks, assessment of functional neurological recovery was done using modified Rankin's Scale (mRS) and was correlated with clinical-radiological parameters and ICH score. The major risk factors of acute haemorrhagic stroke, hypertension and age did not influence functional outcome at 12 weeks ($p>0.05$). However, high mean SBP, DBP and HbA1C at presentation were associated with poor recovery. Among clinical parameters, low GCS and focal neurological deficit strongly correlated with poor functional outcome ($p<0.001$). The functional independence was highest in basal ganglia haematoma (55.8%), followed by lobar (42.9%) and thalamus (35.7%). Cerebellum and brainstem involvement had worst functional outcome. However, the site specific difference was not statistically significant. High haematoma volume (>30 cc), intraventricular haemorrhage (IVH), midline shift, hydrocephalus and low GCS at presentation have been associated with poor functional outcome ($p<0.05$). Functional independence rate for ICH score 0.1 and 2 were 100%, 74% and 54%, respectively at 12 weeks. Clinical and radiological parameters including ICH score can predict and stratify the functional neurological outcome in acute haemorrhagic stroke. Thus in addition to predicting 30 day mortality, ICH score can also help in prognosticating functional outcome in ICH patients.

Keywords: Haemorrhagic stroke, intracerebral haemorrhage, intracerebral haemorrhage score

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INTRODUCTION

Intracerebral haemorrhage or ICH is an annihilating neurological disease that could cause exorbitant mortality and morbidity in adults. Universal burden of hemorrhagic stroke is larger than that of ischemic stroke in relations to fatality and disability, even though the incidence of ischemic stroke is twice as great.[1] Haemorrhagic stroke comprises the Intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH) and intraventricular hemorrhage (IVH) that are not instigated by trauma. Spontaneous ICH is caused by two main arteriopathy-hypertensive angiopathy and cerebral amyloid angiopathy. These two are usually referred as primary ICH. Spontaneous ICH represents 9 to 32 percent of all strokes in world.[2,3] The worldwide annual incidence of spontaneous ICH varies from 12 to 31 per 100,000 persons years.[4-7] The incidence of hemorrhagic stroke in high income countries has declined over the past two decades and increased in low and middle-income countries.[1,2]

1. Department of Medicine, Himalayan Institute of Medical Sciences, Dehradun, Uttarakhand, India.
2. Department of Medicine, Jawaharlal Nehru Medical College, Aligarh Muslim University (AMU), Aligarh. Uttar Pradesh. India.

Correspondence to: Dr. Lubna Zafar, Department of Medicine, Jawaharlal Nehru Medical College, Aligarh Muslim University (AMU), Aligarh. Uttar Pradesh, India. Email: lubzafar@gmail.com

Non-contrast computerized tomography (NCCT) head is a quick tool for diagnosing ICH and is the prevailing diagnostic technique in the emergency department.[3] It not only provides the definitive diagnosis but also shows the precise location of haematoma, ventricular extension, presence of adjacent edema, mass effect and midline shift.[8] These parameters are useful in predicting the mortality as well as functional outcome in acute ICH, which can't be assessed by clinical examination alone.[9,10]

The ICH score is an accepted scoring system to predict 30-day mortality in patients with acute haemorrhagic stroke.[11] It is an easy and standardized grading scale and includes GCS score, ICH volume (<30 cm^3 or ≥30 cm^3), age (<80 or >80 years), with or without intraventricular haemorrhage and the haematoma site (supratentorial or infratentorial).

There are lot of evidence to correlate the clinical and radiological parameters with mortality in ICH. But there is a dearth of research for predicting the functional neurological outcome in these patients. Thus, this study was conducted to evaluate the neurological outcome in ICH patients after their discharge from hospital and on follow up.

METHODS

This prospective, observational, cohort study was undertaken in the Department of Medicine in collaboration with the Departments of Radiodiagnosis at a tertiary care centre of the northern part of India. During a span of two years, 100 patients with the diagnosis of acute hemorrhagic stroke on clinical and brain imaging were included in the study. The study was a hospital based clinical study and not a population-based community study, henceforth the number of subjects enlisted for the study were limited. We, thus, implemented the convenience method of sampling and first 100 subjects of spontaneous ICH were enlisted in the study. All the participants were informed of possible expected benefits and risks ensuing from the study. Informed and written consent of all patients or his/her attendant (when patient was not fit to give his/her consent) was taken in their local language before enrolling in the study.

Eligible patients were ≥18 years presenting with spontaneous acute haemorrhagic stroke. Exclusion criteria included presence of subarachnoid haemorrhage, intracranial haemorrhage secondary to trauma, anticoagulant therapy, antiplatelet drugs, thrombolytic drugs,brain tumour, saccular arterial aneurysm, vascular malformation, venous thrombosis, cocaine addiction, past history of stroke , patients requiring neurosurgical intervention, patients who did not give consent for the study and patients who did not come for follow-up. At baseline, demographic data, history of risk factors for cerebrovascular accidents (systemic hypertension, diabetes mellitus, dyslipidemia, coronary artery disease (CAD), smoking and alcoholism) and presenting clinical features was recorded. Each patient also underwent Non-Contrast CT of head at the time of presentation. CT was performed on Seimens SOMATOM Emotion 16 slice CT scanner. CT was assessed by dedicated expert radiologist for the following parameters:

1. Haematoma site- basal ganglia, thalamus, lobar, cerebellum, brainstem.
2. Supratentorial- (basal ganglia, thalamus and lobar) or Infratentorial- (cerebellum and brainstem)
3. Volume of the haematoma : measured by ABC/2 method – 'A' being the greatest diameter of hematoma on the CT slice with the largest area of haemorrhage, 'B' the largest diameter 90 degrees to 'A' on the same (index) CT slice, while 'C' was the estimated number of CT slices with hemorrhage multiplied by the slice thickness in centimeters. ABC/2 gives the ICH volume in cubic centimeters. The results were evaluated using haematoma volume as <30 cm^3 or ≥30 cm^3.
4. Intraventricular haemorrhage: Present or absent
5. Midline shift: Present or absent
6. Hydrocephalus: Present or absent

Prediction Scores used for study: ICH score and GCS score were calculated in all the patients

Intracereberal Haemmorhage (ICH) score – it is a simple clinical and radiographic grading scale of six points for predicting mortality after ICH.[11]

Glasgow Coma Scale (GCS) – the participants were divided in two groups based on GCS at presentation: GCS <8 and GCS ≥ 8.

Measurement of Outcome: modified Rankin Scale (mRS) – the most widely exercised functional

outcome measurement in stroke studies, as 0=No symptoms, 1=No significant disability despite symptoms: able to perform all usual duties and activities, 2=Slight disability; unable to perform all previous activities but able to look after own affairs without assistance, 3=Moderate disability; requires some help but able to walk without assistance, 4=Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance, 5=Severe disability; bedridden, incontinent and requires constant nursing care and attention.

At presentation clinical and radiological parameters along with GCS and ICH were estimated in all the patients. The patients were assessed after 12 weeks for functional neurological recovery using modified Rankin's Scale (mRS) and were categorized as functionally independent or good outcome (mRS score 0-2) and functionally dependent or poor outcome (mRS3 or more). The neurological recovery at 12 weeks was correlated with the clinical profile, radiological profile and ICH score of the patients at presentation.

Statistical analysis was done by means of Statistical Package for Social Sciences (SPSS) version 25.0 for windows. Results were reported as mean±standard deviation (SD) as well as frequency and percentage. The qualitative data was analysed using Chi-square test and Fisher Exact Test. The quantitative data was also analyzed using Independent t-test. Spearman's correlation coefficient was used to assess correlation between variable. A p-value of less than 0.05 was considered statistically significant.

RESULTS

At the end of 6 weeks, 47% participants had mRS Score 0-2; hence, they were considered as functional dependent and the rest (53%), with mRS score 3-6, were functionally dependent or dead. Both these groups were then correlated with the clinical and radiological finding.

Sex and Functional Outcome: Out of 58 males, 26(44.8%) were functionally independent and out of 42 females, 21 (50%) were functionally independent. There was no significant difference in functional outcome among male and female ($p>0.05$).

Age and Functional Outcome: The mean age of functionally independent patients (56.44±11.93 years) was lower in comparison to dependent or dead (66.87±8.24 years),but not statistically significant ($p>0.05$).

Hypertension and Functional Outcome: Out of 90 hypertensive patients in the study, 41 (46%) were independent and 49 (54%) were dependent or dead at 12 weeks and among normotensive patients, 6(60%) had independent outcome and 4 (40%) had poor outcome. Thus there was no statistically significant difference ($p>0.05$) (Table 1). However, the SBP and DBP at presentation were significantly associated with the functional outcome at 12 weeks ($p<0.05$).

Dyslipidemia and Functional Outcome: Out of 24 dyslipidemic patient, 10 (42%) had independent outcome and 14 (58%) were dependent or dead. There was no significant difference in the functional outcome of dyslipidemic or non-dyslipidemic participants ($p>0.05$) (Table 1).

Diabetes Mellitus and Functional Outcome: The presence of diabetes mellitus did not have statistically significant impact on the functional outcome of stroke patients. ($p>0.05$) (Table 1). However, the HbA1c in independent group was 5.68±0.86 and in dependent group was 6.22±1.14 ($p<0.01$). Neither smoking nor presence of coronary artery disease had statistically significant effect on the functional outcome of ICH patients in the study.

Clinical Presentation and Functional Outcome are presented in the Table 1. There was considerable overlap in clinical presentation of participants. Altered sensorium was present in 60% patients, focal neurological deficit in 75%, headache in 44%, vomiting occurred in 45% of patients and 12 % had seizures at onset. Of all the clinical presentations, altered sensorium and GCS≤8 were statistically associated with poor functional outcome at 12 weeks (OR 40.09, CI 11.80-136.15 and OR 0.0104, CI 0.0025-0.0427 respectively).

GCS Score: Out of 100 patients, 49 patients had GCS score ≤8 of which 3 (6.1%) were independent and 46 (93.9%) were dependent or dead. Of the 51 patients with GCS score >8, 44(86.3%) were independent at 12 weeks and 7(13.7%) were dependent or dead. The independence rate was statistically significant in patient with GCS score >8 ($p<0.001$). The mean GCS score was 12.36±2.80 in good outcome and 5.32±2.54 was in poor outcome patients. The difference between the 2 outcome groups with respect to GCS score was statistically significant ($p<0.001$)

Table 1: Baseline clinical profile and functional outcome of study participants

Risk factors		Dependent or dead	Independent	OR (95% CI)	p-value
Hypertension	Present	49	41	1.7927 (0.4734-6.7881)	0.3902
	Absent	4	6		
Dyslipidemia	Present	14	10	1.3282 (0.5252-3.3591)	0.5488
	Absent	39	37		
Diabetes Mellitus	Present	12	7	1.6725 (0.5977-4.6796)	0.3272
	Absent	41	40		
Smoking	Present	12	9	1.2358 (0.4683-3.2614)	0.6690
	Absent	41	38		
Alcohol	Present	7	6	1.0399 (0.3231-3.3467)	0.9477
	Absent	46	41		
CAD	Present	7	4	1.6359 (0.4472-5.9841)	0.4570
	Absent	46	43		
Symptoms					
Altered Sensorium	Present	49	11	40.0909 (11.80-136.15)	<0.0001
	Absent	4	36		
Focal Neurological Deficit	Present	45	30	3.1875 (1.22-8.3161)	.0178
	Absent	8	17		
Seizure	Present	8	4	1.9111 (0.5362-6.8116)	0.3179
	Absent	45	43		
Headache	Present	25	19	1.3158 (0.5948 – 2.9105)	0.4981
	Absent	28	28		
Vomiting	Present	24	21	1.0246 (0.4653 – 2.2564)	0.9518
	Absent	29	26		
GCS Score	> 8	7	44	0.0104 (0.0025-0.0427)	<0.0001
	≤ 8	46	3		

CT Scan Parameters and Functional Outcomes are presented in the Table 2. Origin of ICH-87% patients had supratentorial haematoma (basal ganglia, thalamus and lobar) and rest 13% had infratentorial location (brainstem and cerebellum). Of the 87 patients with supratentorial ICH, 43(49%) were independent and rest were dependent or dead at 12 weeks, while among 13 patients with infratentorial ICH, 9(69.2%) were dependent or dead. The difference between the two groups was not statistically significant (p>0.05). On site of haematoma, basal ganglia bleed was the most common (52%), followed by lobar (21%), thalamus (14%), cerebellum (7%) and brain stem (6%). Though cerebellar and brain stem haemorrhage had worst functional outcome but the difference between the two outcome groups with respect of site of haematoma was not statistically significant (p>0.05). In the present study, 39 patients had a haematoma volume of ≤5cm^3, of which 34(87%) had independent outcome. In contrast, 16 of 18 patients (89%) patients with haematoma volume 15.1cm^3–30cm^3 had poor functional outcome and in haematoma

volume ≥30cm^3, all participants were dependent or dead at 12 weeks. The difference between the outcome groups with respect to haematoma volume was statistically significant (p<0.001). The mean volume of haematoma was 6.18±5.12cm^3 in independent patients and 29.91±18.11cm^3 in dependent or dead patients.

Intraventricular haemorrhage (IVH) was present in 36 patients of which only 4(11.1%) were functionally independent. In 64 patients without IVH, 43(67.2%) were independent and 21(32.8%) were dependent or deceased. This difference in outcome in respect to IVH was statistically significant (p<0.001). On midline shift, 32 of the 37 patients having midline shift on NCCT head had poor or no recovery at 12 weeks. 67% of 63 patients without midline shift were functionally independent. Thus poor functional recovery was statistically higher in patient with midline shift (p<0.001). All the 15 patients having hydrocephalus were dependent or dead at 12 weeks. Whereas in patients without hydrocephalus, 47 (55.3%) were independent and 38(44.7%) were dependent or dead. Thus poor outcome was statistically higher in patient with hydrocephalus (p<0.001).

Table 2: Radiological parameters at presentation and functional outcome of study participants

CT parameter	Total patients	Independent N=47	Dependent or dead N=53	Chi-square value	p-value
Origin					
Supratentorial	87	43	44	1.5803	.208723
Infratentorial	13	4	9		
Site of Haematoma					
Basal ganglia	52	29	23	3.87	.423878
Lobar	21	9	12		
Thalamus	14	5	9		
Cerebellum	7	2	5		
Brain stem	6	2	4		
Volume of Haematoma (cm^3)					
0-5	39	34	5	50.6034	0.00001
5.1-15	21	11	10		
15.1-30	18	2	16		
>30	22	0	22		
Intraventricular Haemorrhage					
Absent	64	43	21	29.085	0.00001
Present	36	4	32		
Midline shift					
Absent	63	42	21	26.4379	0.00001
Present	37	5	32		
Hydrocephalus					
Absent	85	47	38	15.649	<0.001
Present	15	0	15		

ICH score at presentation was calculated and was 0, 1, 2, 3, 4 and 5 in 21%, 19%, 22%, 23%, 14% and 1% of participants respectively. Functional independence rate for ICH score 0, 1 and 2 was 100%, 74% and 54%. respectively. Rest of participants with ICH score ≥3 had poor recovery or expired by 12 weeks.

The Spearmans correlation coefficient was -0.942 for ICH score and good outcome (Table 3).

Table 3: ICH score at presentation and functional outcome of participants at 12 weeks

ICH score	Independent	Dependent or dead	Fisher Value	p-value
0	21 (100%)	0 (0%)	75.24	<0.001
1	14 (74%)	5 (26%)		
2	12 (54%)	10 (46%)		
3	0 (0%)	23 (100%)		
4	0 (0%)	14 (100%)		
5	0 (0%)	1 (100%)		

DISCUSSION

In the study 42% patients expired during the study period. Similar mortality was observed for ICH at 30 days and ranged from 35%–50% in previous studies.[12-16] In the survivors, 47 patients were functionally independent and 11 were functionally dependent. These finding are consistent with two previous studies.[17,18]

A meta-analysis by Poon et al.[19] observed 32.8% to 42.4% of the ICH patients were functional independent 6 months after ICH whereas only 17% to 24% were functional independent one year after ICH. In another meta-analysis the magnitudes of functional independence varied from 12% to 39% but there were significant differences for follow-up times and outcome evaluations between the 6 involved studies.[6]

Male preponderance was observed among study subjects, with males (58%) outnumbering females (42%), which may be attributed to the high prevalence of smoking[20] and alcohol among males. Other contributing factor may be positive effects of estrogen on the cerebral circulation. Mean age of study population was 58.85±12.47 years, with majority patients in the age group 41-60 years. The age and sex distribution were similar to several other studies.[17,21,22] The effect of age on functional outcome was insignificant, similar to previous studies, in which no correlation was found between age and functional outcome,[17,18] while few other studies suggested that risk for death and disability after ICH upsurges with age.[11,12,23,24]

Hypertension is leading cause of spontaneous ICH but it did not significantly alter functional outcome of participants which is in tandem with several previous studies.[17,25,26] However, SBP and DBP at presentation did influence functional outcome possibly due to haematoma expansion with elevated blood pressure.[27,28] Other factors like diabetes mellitus, dyslipidemia, coronary artery disease, smoking and alcohol did not influence functional outcome in our study.

The incidence of a headache (44%), vomiting (45%), and seizures (12%) in observed in the study were equivalent with similar studies.[17,18,25,29] There was no correlation of vomiting, headache or seizure with functional outcome

The most common site of haematoma in study was basal ganglia (52%), followed by lobar (21%) and thalamus (14%) cerebellum (7%) brain stem (6%). Similar findings have been reported by several previous studies.[11,17,21,22,30-32] Infratentorial location (brain stem followed by cerebellum) had worst functional outcome as compare to supratentorial location but difference was not up to statistically significance. A study by Cheung & Zou[30] also reported infratentorial location is not independent predictor of poor outcome, whereas Hemphill et al.[11] and Samarasekera et al.[33] observed that infratentorial location has a high mortality (30-day and 1-year) compared to patients with supratentorial ICH. The presence of infratentorial haematoma is prognostically poor due to presence of respiratory centre and vasomotor centre in the vicinity.

In our study, IVH, midline shift and hydrocephalus were observed in 36%, 37% and 15% respectively and were identified as bad prognostic sign for functional outcome. The results are similar to the findings of previous studies.[18,31,34] The ventricular system of cerebrum provides a low-pressure pathway for the movement of CSF. IVH can cause structural blocking of cerebrospinal fluid circulation and hydrocephalus, resulting in inflammatory reaction that can damage periventricular tissue.[35]

Among participants, hematoma volume of >30 cm^3 was a harbinger of poor functional outcome. In current study mean hematoma size was significantly high in dependent patients or deceased patients as compared to functional independent patients. Our results are consistent with the previous findings.[18,30,31] In our study,

GCS ≤8 at presentation was associated with high dependence and death. Similar findings were reported in several previous styudies.[18,23,25,30,31] Along with GCS at presentation, the score assessed during the initial five days of event has been observed to correlate better with outcome at 3 months than ICH score. This emphasizes the necessity to reassess the patient regularly.

ICH score is reliable and authentic 6-point clinical and radiographical scoring scales in predicting 30-day mortality in diverse clinical conditions.[11] The goal of the ICH score is to provide a standard evaluation tool that can be calculated easily and rapidly at the time of ICH and predict mortality. However, the current study evaluated the validity of ICH score in relation to functional outcome at 12 weeks rather than mortality in ICH patients. Thus ICH Score is an easy and reliable scale for prediction of short-term functional outcome after ICH occurrence. However, there is still a need for multi-centre studies and prolonged follow-up to validate the use of ICH as a predictive tool for functional outcome in haemorrhagic stroke patients.

Conflict of Interest: None exist.

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Ethical Approval: The study was approved by the Institutional Ethics Committee (IEC) of the Faculty of Medicine, Jawaharlal Nehru Medical College under Aligarh Muslim University, Uttar Pradesh, India (IEC D.No 1010). All the procedures followed in the study were in accordance with institutional guidelines and Declaration of Helsinki.

Authors' Contribution: Both of the authors were equally involved in conception, design, patient selection, data collection, compilation, analysis, manuscript writing, editing, review and final submission.

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