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Prognostic value of intracerebral hemorrhage score in patients with spontaneous intracerebral hemorrhage

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Objective To assess the performance and validity of intracerebral hemorrhage (ICH) score in prediction of 30-day mortality as an outcome of patients with spontaneous ICH.
Methods A prospective study was conducted in the Emergency Department of Baghdad Teaching Hospital during the period from 1st of May 2014 to the end of March 2015. A sample of 45 patients presented with non-traumatic ICH was included. Assessment of the patients with ICH scoring was performed and the total ICH score was calculated for each patient, patients followed up for 30 days and the mortality was reported. The 30-day mortality then compared with the ICH scores.
Results The ICH score for the studied group ranged 1–5, no patients with score 0 or 6. Mortalities reported among patients at each score was 11.1% in those with score 1, 30% in score 2, 85.7% in score 3, 88.9% in score 4 and 100 in score 5. A strong direct significant correlation had been found between ICH score and 30-day mortalities. A progressive increase in the mortalities with the increase in the ICH score ($r = 0.75$, $P < 0.001$), lower Glasgow Coma Scale, the presence of IVH, ICH volume ≥30 ml, and age of >80 years were significantly correlated with higher 30-day mortalities ($P < 0.05$).
Conclusion Higher mortality rates were reported in patients with higher ICH score. The ICH score is a good prognostic tool had an excellent performance in predicting the 30-day mortality in patients with spontaneous ICH.
Keywords Intracerebral hemorrhage, Mortality, Spontaneous ICH.

Introduction

Spontaneous intracerebral hemorrhage (ICH) is the second most common cause of stroke comprising 10–15% of all strokes.[1] It is classified as either primary or secondary. Primary ICH arises from chronic hypertension while secondary (e.g., tumors, cerebral amyloid angiopathy, hemorrhagic transformation of cerebral infarcts, aneurysms, vascular malformations, coagulopathy), and accounts for approximately 78–88% of non-traumatic ICH.[2] Approximately half of all ICH-related mortality occurs within the first 24 h after the initial hemorrhage.[3] Mortality approaches 50% at 30 days.[4,5] Factors associated with poor outcomes include large hematoma volume (>30 mL), posterior fossa location, older age, mean arterial blood pressure >130 mmHg at admission[3,5] and a score of >4 on the Glasgow Coma Scale (GCS) on admission. The same factors are also the most powerful predictors of mortality at 30 days. Hematoma expansion has also been shown to be an independent predictor of diminished functional outcomes, neurological deterioration and mortality.[6–8] The ICH score is a prognostic model for predicting mortality among patients with spontaneous ICH. In an original study of 152 patients with ICH, the authors allocated points for GCS score, ICH volume, presence of intraventricular hemorrhage (IVH), age, and infratentorial origin (Appendix, Table 1) to predict 30-day mortality (Appendix, Table 2), which steadily increases with increasing scores.[9]

Another prognostic tool is the functional outcome risk stratification (FUNC) score. The patient is assessed for risk of functional impairment at 90 days post-stroke. The FUNC scores range from 0 to 11 based on ICH volume, age, site of ICH, GCS score and pre-ICH cognitive impairment.[10] In this study, we aim to assess the performance and validity of ICH score in prediction of 30-day mortality as an outcome of patients with spontaneous ICH.

Patients and Methods

This is a prospective study conducted at the Emergency Department (ED) at Baghdad Teaching Hospital, Medical city complex for the period from 1st of May 2014 to the 1st of March 2015. A total of 45 patients who were admitted to the ED with a proved diagnosis of spontaneous ICH by initial non-contrast CT scan within 24 h of symptoms onset were included in this study. Patients satisfied the following criteria: age 18 years and above, both genders, ICH volume <100 ml. Exclusion criteria were: traumatic ICH, age <18 years, ICH volume ≥100 ml, previous history of ICH. Data were collected through a full history and clinical examination by using a pre-constructed data collection sheet which included socio-demographic data of the patients, past medical history (PMH) and treatment history, past surgical history, baseline clinical, and laboratory and CT scan findings. The non-contrast CT scanning was repeated after 24 h for clinically stable patients for further assessment of ICH. All patients were put under observation at the ED with appropriate clinical management and assessment for 24 h.

Patients were followed up for 30 days after they discharged; patients who were admitted in the medical wards were followed up during their admission period at these wards and then followed up till 30 days. At the end of 30 days of follow up, all mortalities were reported and recorded on the data sheet of participants.

Table 1. **Demographic characteristics of the studied group (*N* = 45)**

Variable		No. (%)
Age (years)	<80	37 (82.2)
	≥80	8 (17.8)
	Mean ± SD*	59.4 ± 11.6 (-)
Gender	Female	24 (53.3)
	Male	21 (46.7)
Smoking	Smoker	18 (40.0)
	Non-smoker	21 (46.7)
	Ex-smoker	6 (13.3)
Alcohol consumption		7 (15.6)
Hypertension (aspirin or warfarin use)		28 (62.2)
Diabetes mellitus		21 (46.7)
Ischemic heart disease (aspirin or warfarin use)		10 (22.2)
Heart failure (warfarin use)		8 (17.8)
Chronic renal failure		5 (11.1)
Hypercholesterolemia		2 (4.4)
Thyrotoxicosis		2 (4.4)
None		8 (17.8)
	Anemia	13 (28.9)
	Leukocytosis	9 (20)
CBC result	Leukopenia	1 (2.2)
	Polycythemia	1 (2.2)
	Normal	21 (46.7)

*Some patients had more than one condition.

Table 2. **ICH score components of the patients**

Item		Score	No. of patients (%)
Glasgow Coma Scale	3–4	2	7 (15.6)
	5–12	1	27 (60.0)
	13–15	0	11 (24.4)
ICH volume	≥30 ml	1	30 (66.7)
	<30 ml	0	15 (33.3)
IVH	Present	1	26 (57.8)
	Absent	0	19 (42.2)
ICH location	Infratentorial	1	31 (68.9)
	Supratentorial	0	14 (31.1)
Age	≥80	1	8 (17.8)
	<80	0	37 (82.2)

Verbal consents of all patients (guards) were obtained prior to participation in the study.

Statistical Analysis

Data were entered and analyzed by using the statistical package for social sciences (SPSS) software for windows version 22/ IBM/ USA-2014. Descriptive statistics were presented as mean, standard deviation, frequencies (number of patients) and proportions (%). The receiver operation characteristics (ROC) curve was used to test the performance and accuracy of ICH score for predicting the 30-day mortality; the area under the curve (AUC) ranged 0–1, the larger AUC indicated the better performance and prediction, the score of 3 was used as cut-off point in conducting the ROC curve. Also, the ROC curve was used to estimate the sensitivity, specificity, positive and negative predictive value of the ICH score in prediction for the outcome level of significance (*P*-value) was set at ≤0.05 to be considered as significant.

Results

The mean age of the patients was 59.4 ± 11.6 years. Thirty seven patients (82.2%) aged <80 years, eight patients (17.8%) aged 80 years and above. Female patients were 24 (53.3%) of the studied group and males were 21 (46.7%). Female to male ratio was 1.14:1. Current smokers were 18 (40%), none smokers were 21 (46.7%) and six patients (13.3%) were ex-smokers. Only seven patients (15.6%) were alcohol consumers (Table 1).

About 28 patients (62.2%) had history of hypertension, 21 (46.7%) with DM, 10 (22.2%) with ischemic heart disease, eight patients with heart failure (17.8%), five (11.1%) with chronic renal failure, two (4.4%) with history of hypercholesterolemia and another two (4.4%) with history of thyrotoxicosis, while eight patients (17.8%) had no PMH (Table 1).

Among the 45 patients in this study, seven patients (15.6%) had GCS of 3–4, giving a score of 2 on ICH scoring, 27 patients (60%) with GCS of 5–12 (score 1) and 11 patients had GCS of 13–15 (score 0). The ICH volume of ≥30 ml (score 1) was reported in 30 patients (66.7%) and the remaining 15 patients (33.3%) had ICH volume of <30 ml (score 0) (Table 2).

By summation of scores of the ICH scoring component of the patients, we found that nine patients (20%) had ICH score of 1, 10 patients (22.2%) had ICH score of 2, seven patients (15.6%) scored 3, nine patients (20%) scored 4 and 10 patients (22.2%) scored 5.

Out of nine patients with ICH score of 1, only one (11.1%) died (expected 30-day mortality risk 13%), three of the 10 patients with score 2 died giving mortality of 30% (Expected; 26%) (Table 3). From another point of view, it was clearly noticed that the 30-day mortality rates of the patients (who died within 30 days of follow up) increased with the higher ICH score, the correlation coefficient (*r*) of Spearman's rho test

Table 3. **Distribution of the studied group according to the total ICH score and real mortality rates compared to 30-day mortality risk**

ICH score	No. of patients	Real mortality (died within 30 days)	30-Day mortality risk (%)	Statistics
		No. (%)		
1	9	1 (11.1)	13	$r = 0.75$, $P < 0.001$
2	10	3 (30.0)	26	
3	7	6 (85.7)	72	
4	9	8 (88.9)	97	
5	10	10 (100)	100	
Total	45	28 (62.2)	-	

was (0.75, $P < 0.001$), indicated strong association between the higher score and higher mortality rates.

By using the Spearman's Rho correlation test and ROC curve test it had been found that higher ICH score was strongly correlated with higher 30-day mortality rates of the patients ($r = 0.75$, $P < 0.001$), on the other hand, the ROC curve revealed that ICH score was highly sensitive and specific in prediction of 30-day mortality; by using the ICH score cut-off point of 3 and 30-day mortality as an outcome, the sensitivity of ICH score was 85.7% and the specificity was 88.2% and accuracy of 86.7%, positive predictive value of 92.3% and negative predictive value of 78.9%. On the other hand, the AUC was 0.92 indicated excellent performance of the ICH score in predicting the outcome (Figs. 1–3).

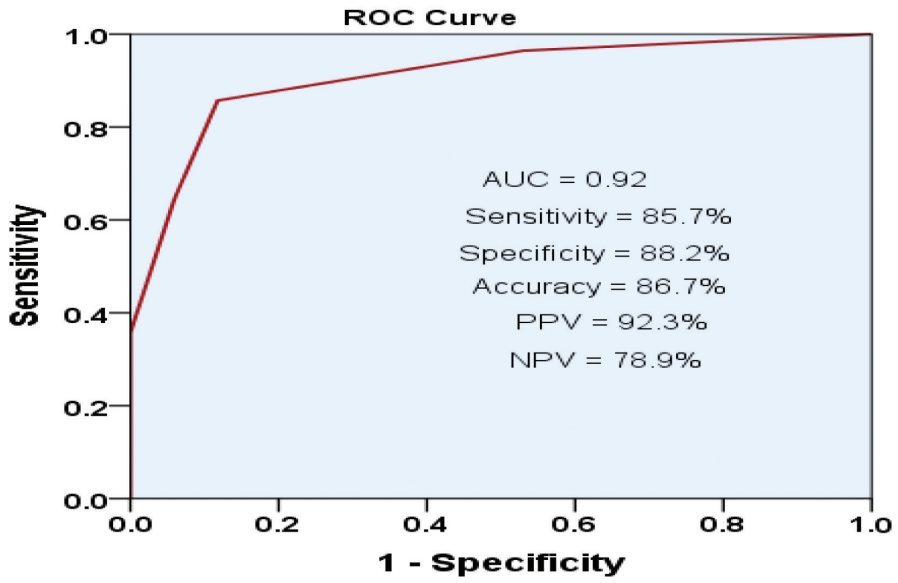

Fig. 1 **The receiver operating characteristics curve (ROC) shows the validity of ICH score in prediction of 30-day mortality.**

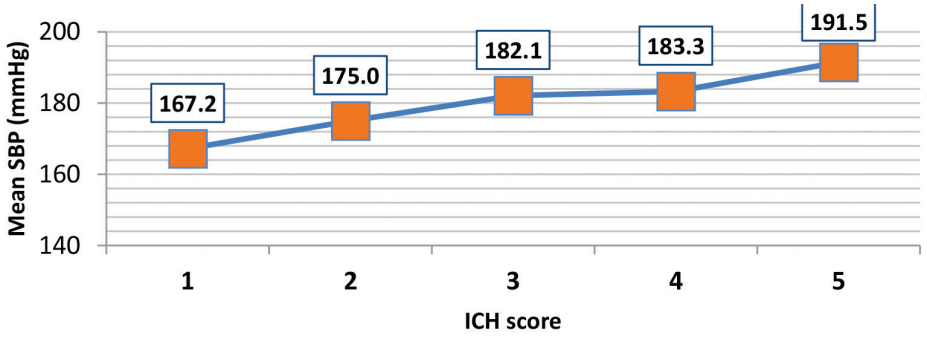

Fig. 2 **Direct correlation between ICH score and mean systolic blood pressure (SBP) of the patients.**

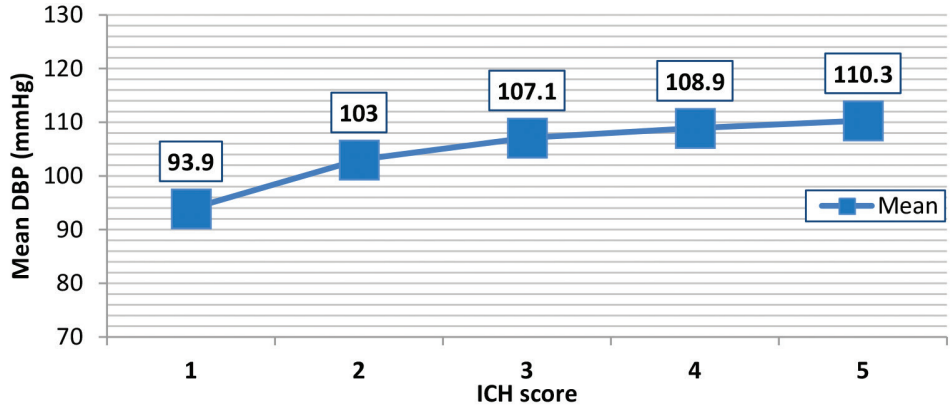

Fig. 3 **Direct correlation between ICH score and mean diastolic blood pressure (DBP) of the patients.**

Discussion

There are many models for prediction of the outcome after intracerebral hemorrhage and there is a wide variation in the mortality rate of patients with ICH at 30 days.[1,11,12] The ICH score is the most popular clinical score used in predicting the 30-day mortality as well as the short- and long-term functional outcome of ICH.[13–19] Currently, it has been widely recognized by the academic professionals as a useful prognostic evaluation scale due to its simplicity and accuracy.[20,21] Many revisions of the ICH score have been developed by investigators worldwide to try to improve the accuracy of the model.[20] The overall mortality reported in this study was 62.2%, where 28 patients out of the 45 died within 30 days. Despite this higher mortality rate, previous studies reported a wide variation in the mortality rates among patients with ICH at 30 days. In a systematic review was conducted by van Asch et al.[22] in 2010 the median case fatality of ICH at 1 month was 40.4% (range 13.1–61.0) and did not decrease over time, and was lower in Japan (16.7%). Another study from China was conducted by Zhang et al.[23] in 2003 reported a 28-day mortality of 49.4%. Moreover, the mortality rate in our study was higher than that reported by Jamora et al.[15] in 2003, who found an overall 30-day mortality rate of 23%. Another study was conducted in 2009 by Patriota et al.[16] reported an overall 30-day mortality of 37.8% and also they found that it did not differ from the 1-year mortality. Muengtaweepongsa and Seamhan[21] in 2013 found an overall mortality rate of 18%. Additionally, Qureshi et al.[1] mentioned that mortality rate in patients with ICH was 31% at 7 days, 34% at 3 months, 59% at 1 year, 82% at 10 years, and more than 90% at 16 years after onset ICH. However, this variation in the overall mortality rates might be attributed to different factors. First, the study populations for derivation are different. The baseline characteristics of our study were different from those of other cohorts used to develop prior ICH scores, such as age of ICH onset, severity of neurological deficit, hematoma volume on admission, however, it is not our primary aim to compare the differences of these ICH cohorts and it is hard to explain the reasons due to differences in study design and study population. Second, there might be complex genetic, social, cultural, and economic factors as well as regional management philosophies and preferences that are difficult to account for when applied to a distinct population. In this study there was a clear trend that the 30-day mortality rate increased with the increase of the ICH score, where the mortality rate was 11.1%, 30%, 85.7%, 88.9% and 100% among patients with ICH score of 1–5, respectively and our study has confirmed that the higher ICH score was strongly associated ($r = 0.75$, $P < 0.001$) with higher mortality rates. No patient in this study had an ICH score of 6, however, because no patient with an ICH score of 5 survived, an ICH score of 6 would be expected to be associated with a high likelihood of mortality,[14] this finding agreed the findings of previous studies; Hemphill et al.[9] reported that the ICH score is a simple clinical grading scale that allows risk stratification on presentation with ICH and he mentioned that 30-day mortality increased steadily with ICH score ($P < 0.005$).

Similarly, Patriota et al.[16] showed a progressive increase in 30-day mortality associated with the increase in the ICH score ($P < 0.05$).

This study showed that four of the component of ICH score were significantly correlated with higher 30-day mortality rates; these included lower GCS ($r = 0.55$, $P < 0.001$), presence of IVH ($r = 0.73$, $P < 0.001$), ICH volume ≥30 ml ($r = 0.30$, $P = 0.001$) and age of 80 years and above (scale $r = 0.36$, $P = 0.014$). These findings indicated higher risk of 30-day mortality, these findings consistent with findings of previous studies, in a study was conducted on Thai ICH patients, Muengtaweepongsa and Seamhan[21] found that, infratentorial ICH, GCS (3–4), ICH volume > 30 cm^3 and presence of intraventricular hemorrhage were the significant parameters associated with higher mortality.

Similarly, Yousuf et al.[24] from Malaysia showed that the low GCS is a significant predictor of 30-day mortality.

In this study the AUC of the ROC was 0.92 which was similar to Hemphill's 2009 study (0.92) and very close to (0.882) that reported by Wang et al.'s study, and also Clarke's study (0.88).[12,25,26] Furthermore, our finding was higher than findings of Peng's study (0.72), Chuang's study (0.74) and Stein's study (0.736).[27–29]

From another point of view, Goody et al.'s[30] study in 2006 found that ICH score is a good predictor for 30-day mortality with sensitivity of (75%), specificity (84%), PPV (71%) and NPV of (87%), and the ROC AUC was 0.88. Our study has some limitations, first is the restriction in time of the study resulted in restriction of sample size, additionally recruited patients only from a single medical center, secondly the functional outcome of the patients was not evaluated due to the limitation of the ICH score that does not account for functional outcome.[31] Third, ICH score can change rapidly due to decline or changes in GCS or hematoma expansion, likewise, early interventional therapies may improve the score with hematoma evacuation, hemicraniectomy.

Conclusion

The overall 30-day mortality was 62.2% and it was higher than that reported in other countries. The reported 30-day mortality among the ICH patients was directly correlated with the ICH score and there was a progressive increase in the mortality rate with the increase in the ICH score. Lower GCS, the presence of IVH, ICH volume ≥ 30 ml and age of 80 years or older are significantly correlated with higher 30-day mortality rates. The ICH score was, effective in predicting the 30-day mortality with excellent performance, high validity and reliability and could be a useful prognostic tool in patients with ICH.

Recommendations

Using the ICH score at 24 h of onset of ICH will be more effective than its use at admission due to dynamic changes in some of its components like the GCS and IVH and volume of ICH which might also been affected by different modalities of treatment, so that the 24 h ICH score would be better than at admission.

Conflicts of Interest

None.

Appendix

Table 1. **Components for ICH score**

Feature	Score points
Glasgow Coma Scale	
3–4	2
5–12	1
13–15	0
ICH volume	
≥30 ml	1
<30 ml	0
IVH	
Present	1
Absent	0
ICH location	
Infratentorial	1
Supratentorial	0
Age (years)	
≥80	1
<80	0

Table 2. **Thirty-day mortality risk according to ICH score**

Total score points	30-day mortality (%)
0	0
1	13
2	26
3	72
4	97
5	100
6	100 (estimated)

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