Observational Study

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In-hospital outcomes of patients with spontaneous supratentorial intracerebral hemorrhage

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Abstract

Spontaneous intracerebral hemorrhage (ICH) in the brain parenchyma accounts for 16.1% of all stroke types in Taiwan. It is responsible for high morbidity and mortality in some underlying causes. The objective of this study is to discover the predicting factors focusing on in-hospital outcomes of patients with spontaneous supratentorial ICH.

Between June 2014 and October 2018, there were a total of 159 patients with spontaneous supratentorial ICH ranging from 27 to 91 years old in our institution. Twenty-three patients died during hospitalization, whereas 59 patients had an extended length of stay of >30 days. The outcomes were measured by inpatient death, length of stay, and activity of daily living (ADL). Both univariate and multivariate binary logistic regression, as well as multivariate linear regression, were used for statistical analysis.

Multivariate binary linear regression analysis showed the larger hematoma in initial computed tomography scan of >30 cm^3 (odds ratio [OR] = 2.505, P = .013) and concurrent in-hospital infection (OR = 4.173, P = .037) were both statistically related to higher mortality. On the other hand, in-hospital infection (≥17.41 days, P = .000) and surgery (≥11.23 days, P = .001) were correlated with a longer length of stay. Lastly, drastically poor change of ADL (ΔADL <–30) was associated with larger initial ICH (>30 cc, OR = 2.915, P = .049), in-hospital concurrent infection (OR = 4.695, P = .01), and not receiving a rehabilitation training program (OR = 3.473, P = .04).

The results of this study suggest that age, prothrombin, initial Glasgow Coma Scale, computed tomography image, location of the lesion, and surgery could predict the mortality and morbidity of the spontaneous ICH, which cannot be reversed at the time of occurrence. However, effective control of international normalized ratio level, careful prevention against infection, and the aid of rehabilitation programs might be important factors toward a decrease of inpatient mortality rate, the length of stay, and ADL recovery.

Abbreviations: ADL = activity of daily living, CT = computed tomography, GCS = Glasgow Coma Scale, ICH = intracerebral hemorrhage, MLS = midline shift.

Keywords: cerebrovascular disorders, in-hospital outcomes, stroke, intracerebral hemorrhage

1. Introduction

From among all types of strokes, spontaneous (or nontraumatic) intracerebral hemorrhage (ICH) is the most severe type and is associated with significant mortality and morbidity rates throughout the entire world,[1] which affects around 2 million people in the world each year.[2] Previous studies illustrate overall 30-day mortality of 30% to 55%, with <20% of all ICH patients regaining functional independence at 6 months.[3–8] The 12-month fatality rate, disability rate, and recurrence rate were 17.7%, 29.2%, and 3.7%, respectively.[9] The ICH score introduced by Hemphill and colleagues in 2001[10] significantly helped clinical physicians standardize clinical decision-making and research protocols among providers from around the globe. However, this scoring system tends to overestimate poor outcomes in many patients in our clinical experience. In a retrospective review, the mortality rate of patients with a total ICH score of 3 or 4, regardless of whether there was surgical intervention or not, was predicted to be markedly lower than it should have been.[11] Subsequent clinical studies included broader clinical and radiological factors such as age, level of consciousness, hypertension, the volume of the hematoma, volume of perifocal edema, midline shift (MLS) displacement on computed tomography (CT) scan, and intraventricular spread of ICH as indicators for poor prognosis.[12–15] However, few studies have attempted to identify factors related to favorable and unfavorable functional outcomes.

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are publicly available.

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This study aims to find the compounding factors that resulted in in-hospital mortality rate, prolonged length of stay, and drastic deterioration of activity of daily living (ADL) of patients suffering from spontaneous supratentorial ICH.

2. Materials and methods

2.1. Patients selection

This retrospective study was performed between June 2014 and October 2018, enrolling all patients admitted with spontaneous supratentorial intraparenchymal hemorrhage who were medically or surgically treated in our medical unit at Chiayi Chang Gung Memorial Hospital, Taiwan. The Institutional Review Board of Chang Gung Memorial Hospital approved the project (IRB number: 202000021B0).

2.2. Inclusion/exclusion criteria

Patients were included if presenting with spontaneous intraparenchymal hemorrhage. Patients aged <18 years, with isolated intraventricular hemorrhage (IVH), with intraparenchymal hemorrhage at infratentorial origin, or with ischemic stroke-related hemorrhagic transformation were excluded from this study (see Fig. 1).

2.3. Choice of surgical or medical treatment

Surgery was suggested by our neurosurgeons when patients met the following criteria: hematoma volume >30 cc, a mass effect of the hematoma and surrounding edema >5 mm on midline structures, and deteriorating neurological status on the Glasgow Coma Scale (GCS). Our study population consisted of a large portion of elderly people, whose family intended to refuse surgically feasible ICHs and wanted medical treatment only. The final decision on undergoing surgical evacuation or not was up to each case and their family. Regardless of surgery or medical treatment, intensive systolic blood pressure management was set to <160 mm Hg. We generally used codeine for pain and agitation control and gave the patients adequate intravenous isotonic saline hydration.

2.4. Euroimaging evaluation

All patients were scanned using CT scanners to obtain images with 0.5-mm slice thickness. The hematoma volume was estimated using the well-known ellipsoidal method. Other parameters, including the swirl signs, MLS, and concurrence of IVH, were noted.

2.5. Analytic technique

Statistical Package for the Social Sciences (SPSS) version 25 for Mac was used for analysis. The binary logistic regression and linear regression were used for statistical analysis. The differences were considered statistically significant when a *P* value was <.05.

2.6. Risk of bias

The use of early do-not-resuscitate orders bias predictive models of ICH outcome, making it looks worse than it would if timely surgical intervention and aggressive medical care was provided.

3. Results

3.1. Patients characteristics

Between June 2014 and October 2018, a total of 159 patients with spontaneous supratentorial intraparenchymal hemorrhage ranging from 36 to 91 years old were retrospectively included in this study. The algorithm is depicted in the following chart (Fig. 1). The mean age was 64.0 years, and 98 (61.6%) patients were male. The median GCS score was 11.4, and the median hematoma volume was 27.6 cm^3. One hundred thirteen (71.1%) patients had an ICH volume of ≤30 cm^3, while 50 (31.4%) patients had an ICH volume of >30 cm^3. Twenty-three (14.5%) cases died during hospitalization, while 5 (15.7%) cases experienced in-hospital deterioration of ADL score of ≤–30 (shown in Table 1).

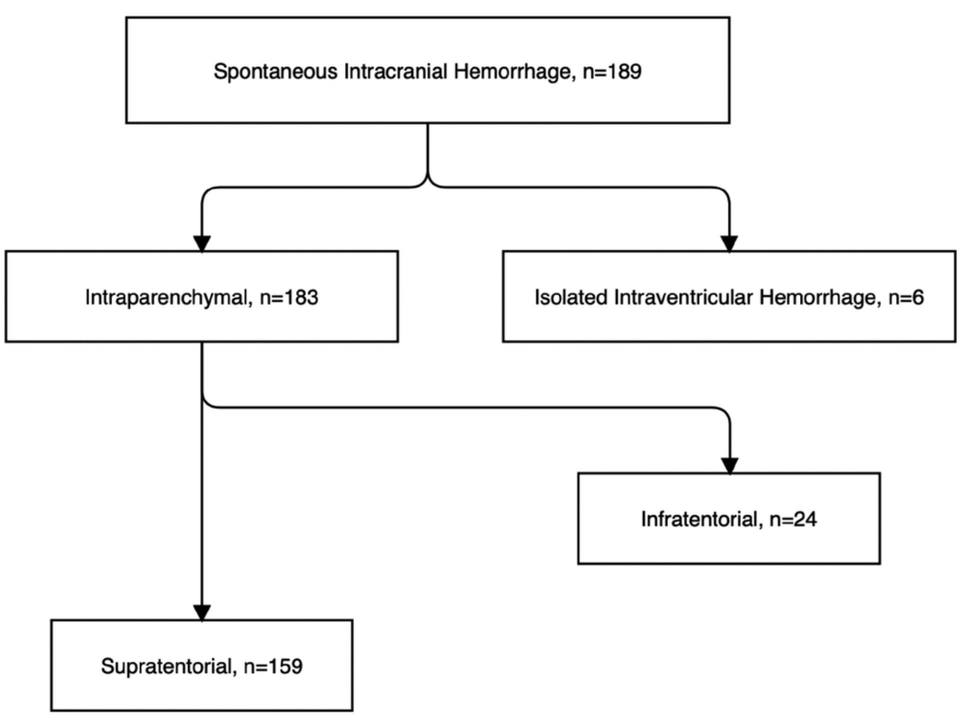

Figure 1. Flowchart of the patient selection.

Table 1

Patient characteristics.

Parameters	Values
Age, yr	64.0 (36–91)
<40	7
41–50	21
51–60	39
61–70	33
71–80	31
>80	28
Sex	
Male	98
Female	61
INR	
≤1.5	27
>1.5	132
Initial Glasgow Coma Scale	
≤8	35
9–12	47
13–14	13
15	64
Initial systolic blood pressure	178.3
≤120	11
121–140	16
141–160	24
161–180	32
181–200	30
>200	46
Swirl sign	
Present	97
Absent	62
Concurrent intraventricular hemorrhage	
Present	60
Absent	99
Initial ICH volume, cc	27.4
≤30	113
>30	47
Midline shift, mm	
≤5	126
>5	33
Surgery	
Underwent surgery	42
Conservative treatment	117
Infection	
In-hospital sepsis	59
No	100
Rehabilitation	
Receive rehab program	63
No	96
In-hospital mortality	
Yes	23
No	136
Hospital length of stay	
≤7 d	39
8–14	31
15–30	35
>30	54
Δ Activity of daily life	
<–30	5
>–30	154

ICH = intracerebral hemorrhage, INR = international normalized ratio.

3.2. In-hospital mortality

The results of the univariate logistic regression for all the variables (Table 2) showed that in-hospital mortality was associated with advanced age of >70 years (odds ratio [OR] = 2.278, 95% confidence interval [CI] = 1.031–3.525, P = .034), prolonged prothrombin time (OR =b1.936, 95% CI = 1.474–2.425 P = .009), worse initial GCS score in emergency room (OR = 0.978, 95% CI = 0.472–1.484, P < .001), evidence of Swirl sign on CT scan (OR = 3.852, 95% CI = 3.494–4.210, P = .001), initial hematoma volume on CT scan >30 cm^3 (OR = 1.892, 95% CI = 1.343–2.441, P = .009), in-hospital surgical evacuation of the hematoma (OR = 2.102, 95% CI = 1.657–2.547, P = .004), and concurrent in-hospital infection (OR = 4.309, 95% CI = 3.821–4.797, P = .023). On multivariate logistic regression (Table 3), only larger initial hematoma volume on CT scan of >30 cm^3 (OR = 2.505, 95% CI = 2.303–2.707, P = .013), and concurrent in-hospital infection (OR = 4.173, 95% CI = 3.492–4.854, P = .037) were statistically related to higher mortality.

Table 2

Factors lead to higher in-hospital mortality (univariate logistic regression).

	Odds ratio	95% confidence interval	*P* value
Age	2.278	1.031–3.525	**.034***
INR	1.936	1.047–2.425	**.009***
Initial GCS	0.978	0.472–1.484	**<.001***
Initial SBP	0.236	−1.082 to 1.054	.145
Swirl sign	3.852	3.494–4.210	**.001***
IVH	0.640	−0.603 to 1.882	.313
Initial MLS	1.742	0.494–3.978	.471
Initial ICH volume	1.892	1.343–2.441	**.016***
Surgery	2.102	1.657–2.547	**.004***
Infection	4.309	3.821–4.797	**.026***

GCS = Glasgow Coma Scale, ICH = intracerebral hemorrhage, INR = international normalized ratio, IVH = intraventricular hemorrhage, MLS = midline shift, SBP = systolic blood pressure.
*P < .05, clinical significance.

3.3. Prolonged length of stay

On binary logistic regression (Table 4), the result significantly showed that the evidence of concurrent in-hospital infection prolonged hospital stays by up to 17.41 more days (95% CI = 11.22–23.60, P < .001), where surgical evacuation of the hematoma resulted in 11.23 more days of hospital stay (95% CI = 5.51–16.95, P = .001).

3.4. Drastic deterioration of ADL

Interval change of ADL initially and at the time of discharge was recorded in this study. Drastic deterioration of ADL is defined as Δ <–30. The results of the multivariate logistic regression for all the variables (Table 5) showed that drastic deterioration of ADL was associated with initial hematoma volume on CT scan of >30 cm^3 (OR = 2.915, 95% CI = 1.827–4.003,

Table 3

Factors lead to higher in-hospital mortality (multivariate logistic regression).

	Odds ratio	95% confidence interval	*P* value
Initial ICH volume	2.505	2.303–2.707	**.013***
Infection	4.173	3.492–4.854	**.037***

ICH = intracerebral hemorrhage.
*P < .05, clinical significance.

Table 4

Factors lead to prolonged length of stay (multivariate logistic regression).

	μ	95% confidence interval	*P* value
Infection	17.41	11.22–23.60	**<.001***
Surgery	11.23	5.51–16.95	**.001***

*P < .05, clinical significance.

Table 5

Factors lead to drastic deterioration of ADL (univariate logistic regression).

	Odds ratio	95% confidence interval	*P* value
Age	1.992	1.240–2.744	.067
INR	2.941	1.813–4.069	.056
Initial GCS	2.087	1.080–3.094	.148
Initial SBP	1.479	−1.080 to 1.878	.230
IVH	1.038	−0.356 to 2.432	.923
Initial MLS	1.742	0.529–2.955	.713
Initial ICH volume	2.915	1.827–4.003	**.049***
Surgery	0.189	−1.139 to 1.517	.971
Infection	4.675	3.773–5.617	**.001***
No rehab	3.473	2.613–4.333	**.004***

ADL = activity of daily living, GCS = Glasgow Coma Scale, ICH = intracerebral hemorrhage, INR = international normalized ratio, IVH = intraventricular hemorrhage, MLS = midline shift, SBP = systolic blood pressure.

*$P < .05$, clinical significance.

$P = .049$), concurrent in-hospital infection (OR = 4.695, 95% CI = 3.773–5.617, $P = .001$), and no arrangement of a rehabilitation program during hospitalization (OR = 3.473, 95% CI = 2.613–4.333, $P = .004$). However, advanced age of >70 years (OR = 1.992, 95% CI = 1.240–2.744, $P = .067$) and prolonged prothrombin time (OR = 2.941, 95% CI = 1.813–4.069, $P = .056$) provided a trend for poor outcome without statistical significance.

4. Discussion

To assess clinical outcomes of patients suffering from spontaneous supratentorial ICH, well-designed grading scales may play an important role. As mentioned above, the ICH score proposed by Hemphill et al was widely used in current practice. However, only 30-day mortality related to 5 parameters were taken into considerations, including GCS score, ICH volume, presence of IVH, infratentorial ICH, and age. Also, some physicians found that the ICH scoring system may have overestimated the mortality rate. Besides, several prognostic models for ICH have been developed and validated in other studies, leading to better patient mortality and functional outcome predictions. Our study focused on 3 primary in-hospital outcomes for the analysis, including in-hospital mortality rate, prolonged length of stay, and drastic deterioration of ADL. In an attempt to find new explanatory variables, we included prolonged prothrombin time, MLS of septum pellucidum, neurosurgical intervention, concurrent infection, and rehabilitation programs.

The overall mortality rate in our study was around 14.5%. When compared to the existing literature, our retrospective cohort produced similar results.[16–20] The currently used ICH score is probably the most popular prognostication tool.[10,21] However, because the current ICH scores do not fully display the complication burden of spontaneous ICH, it leads to a potential source of false predictions. A survey from an intensive care unit indicated that only 10% of neurologists, and 8% of neurosurgeons would routinely use the ICH score.[22] Other studies also have interrogated the clinical utility of the ICH scores on mortality rate.[5,6,8,11,23] The Neurocritical Care Society has highlighted the importance of designing an exceptional prediction model for stroke patients.[24] The ultimate goal is to find a rapid and straightforward assessment with accurate prognosis prediction, including mortality rate and functional outcome. More importantly, complete validation of all the possible predisposing and influencing factors in the prediction models should be included because those factors in clinical studies may be subject to selection bias or may not be reproducible across multiple studies.[25,26]

For prolonged length of stay and drastic deterioration of ADL, there were not many studies discussing those 2 outcomes. Although the association between spontaneous supratentorial ICH and the above-mentioned factors are clinically recognized, the currently available data do not support a statistically significant relationship.[27] The upgraded strategies for ICH management are to focus on reducing ICH-related acute effects that may eventually result in improvement of the outcomes in patients.[28,29] It may be best achieved by targeting the aggravating risk factors, including the controlling of high blood pressure, the prevention of in-hospital infection and the aid of rehabilitation programs. A personalized and planned nursing plan could enhance the rehabilitation and compliance of the patient, which could help the patients recover daily activities and neurological functions as soon as possible.[30]

Lastly, there are some limitations to the present study. It is retrospectively designed, which is limited to a single medical facility. The sample size of this study is relatively small compared to published studies at other medical centers. Another limitation is that we had only in-hospital records. The long-term follow-up data of patients was not feasible after they were discharged from our hospital.

5. Conclusions

The results of this study suggest that age, prothrombin, initial GCS, CT image, location of the lesion, and surgery could predict the mortality and morbidity of the spontaneous ICH, which cannot be reversed at the time of occurrence. However, careful prevention against infection and the aid of rehabilitation programs might significantly decrease inpatient mortality rate, the length of stay, and improve ADL recovery. In the future, it is necessary to establish more reliable ICH prognostic prediction scores that provide information about patients' clinical outcomes to achieve patients' medical needs and facilitate the implementation of new therapies.

Author contributions

Conception and design: Jen-Tsung Yang
Acquisition of data: Chao-Chun Yang
Analysis and interpretation of data: Chao-Chun Yang
Drafting the article: Chao-Chun Yang
Critically revising the article: Jen-Tsung Yang
Reviewed submitted version of manuscript: All authors.
Statistical analysis: Chao-Chun Yang
Study supervision: Ming-Hsue Lee, Kuo-Tai Chen, Jen-Tsung Yang

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