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 cm³ (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 higher mortality. On the other hand, in-hospital infection (≥17.41 days, P = .000) and surgery (≥11.23 days, P = .013) were both statistically related and concurrent in-hospital infection (OR = 4.173, 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.[3–6] The 12-month fatality rate, disability rate, and recurrence rate were 17.7%, 29.2%, and 3.7%, respectively.[7] 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.[12–13] Few studies have attempted to identify factors related to favorable and unfavorable functional outcomes.

The author(s) 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 cm³. One hundred thirteen (71.1%) patients had an ICH volume of ≤30 cm³, while 50 (31.4%) patients had an ICH volume of >30 cm³. 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.](image-url)
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 = 1.936, 95% CI = 1.047–2.425, $P = .009$), 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 = 3.821–4.854, $P = .023$). 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, $P < .001$), and concurrent in-hospital infection (OR = 4.173, 95% CI = 3.492–4.854, $P = .037$) were statistically related to higher mortality.

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 $\Delta < -30$. 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, $P = .037$).
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. 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. 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.

Last, 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**

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Study supervision: Ming-Hsue Lee, Kuo-Tai Chen, Jen-Tsong Yang

**Table 5**

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

| Factor                  | 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    |
| NIH                     | 1.038      | –0.356 to 2.432         | .923    |
| Initial MLS             | 1.742      | 0.529–2.965             | .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.

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