# Predictors of Mortality Based on CT Scan Findings of Patient Admitted Due to Hypertensive Intracerebral Hemorrhage at the Philippine Heart Center

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***Background ---*** Intracerebral hemorrhage accounts for 10 to 15 percent of all cases of stroke and is associated with the highest mortality rate. Once an ICH occurs, the most efficient way to localize the hemorrhage is Computed Tomography. Hypertensive hemorrhages appear on CT as areas of high density with sharply defined borders. According to previous studies, the mortality rate six months after spontaneous ICH ranges from 23 to 58 percent. A low score on the Glasgow Coma Scale, a large volume of the hematoma, and the presence of ventricular blood on the initial CT scan are factors that have been consistently identified as predictive of a high mortality rate. This study was conducted to determine the predictors of mortality based on the CT scan finding of patient admitted due to hypertensive intracerebral hemorrhage at the Philippine Heart Center.

***Methods ---***This was a retrospective cohort study involving 124 patients with hypertensive intracerebral hemorrhage (HICH) on their CT scan. Their plates and medical records were reviewed together. The following items were analyzed in each patient in order to determine the predictors of mortality with HICH patient: age, sex, status, occupation, co-morbidities, years of hypertension, blood pressure, hospital stay, management, outcome, presence of midline shift/ herniation, intraventricular and subarachnoid hemorrhage, hydrocephalus and hematoma volume in there ct scan result. Independent predictors of mortality were determined using univariate and multivariate analysis.

***Results ---*** Using univariate analysis the following parameters shows significant result ($p< 0.05$); age, duration of hypertension (years), occupation, hospital stay and the presence of subarachnoid hemorrhage in the CT scan result. We then use the five parameters that give significant result using the multivariate analysis and only one showed significant value which was the presence of subarachnoid hemorrhage in the CT scan ($p=0.0358$), that gives three (3) times higher risk of dying in patient with HICH.

***Conclusion ---*** The presence of subarachnoid hemorrhage in the CT scan findings of patient admitted due to HICH gives three times higher risk of dying to the patient, thus a good predictor of mortality. ***Phil Heart Center J 2007; 13(2):155-160.***

**Key Words:** Hypertensive Intracerebral hemorrhage ■ Subarachnoid Hemorrhage ■ Hemorrhagic Strokes ■ Computed Tomography, Mortality

The worldwide incidence of intracerebral hemorrhage (ICH) ranges from 10 to 20 cases per 100,000 population 4,8 and increases with age, 90% of them being older than 45 years.[4] Intracerebral hemorrhage is more common in males than females, with males having a 5-20% higher incidence of ICH than females.[4] Certain populations are also predisposed to ICH such as Japanese and black since a higher incidence of hypertension is seen in these people younger than 45 years.[4]

Intracerebral hemorrhage accounts for 10 to 15 percent of all cases of stroke and is associated with the highest mortality rate, with only 38 percent of affected patients surviving the first year. Depending on the underlying cause of bleeding, intracerebral hemorrhage is classified as either primary or secondary. Primary ICH, accounting for 78 to 88 percent of cases, originates from the spontaneous rupture of small vessels damaged by chronic hypertension or amyloid angiopathy. Secondary ICH occurs in a minority of patients in association with vascular abnormalities (such as arteriovenous malformations and aneurysms), tumors, or impaired coagulation.

Hypertensive intracerebral hemorrhage is the most common from ICH. According to the autopsy study of McCormick and Rosenfield, hypertension represents the main causative factor for ICH. The frequency of hypertension in a series of patients with ICHs varies widely from 40 to 89 percent, even in studies applying careful definitions of hypertension. When the blood pressure is chronically high, blood vessels may develop small weakened areas (microaneurysms) from constant pressure on the vessels walls. These microaneurysms (Charcot-Bouchard aneurysms)

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can leak into the tissues and in time, blood irritates the brain tissues causing swelling (cerebral edema). The blood collects into a mass (hematoma). Both swelling of the brain tissues and the presence of hematoma within put increasing pressure on the brain tissues and eventually destroys them. Bleeding may occur into the ventricles of the brain or into the subarachnoid space (the space between the brain and the membranes covering the brain), causing symptoms of meningeal irritation.

Intracerebral bleeding associated with hypertension occurs most often in the putamen/external capsule (40%), lobar white matter of the cerebral hemispheres (22%), thalamus (15%), pons and cerebellum (8%), and caudate (7%). Notably, hypertension increases the risk of intracerebral hemorrhage, particularly in persons who are not compliant with antihypertensive medication, are 55 years of age or younger, or are smokers. Improved control of hypertensive appears to reduce the incidence of ICH. Typically, active bleeding in hypertensive intracerebral hemorrhage (HICH) is relatively acute and usually lasts less than an hour. Cerebral edema rapidly ensues and progresses for 24 to 48 hours after ictus. Although the clinical course of HICH is highly variable, about 25 percent of patients die within the first 48 hours. Delayed neurologic deterioration occurs in small percentage of cases and is usually due to rapid clot expansion with secondary brain herniation. Delayed hemorrhage usually occurs in patients with persistent hypertension.

Once an ICH occurs, the most efficient way to localize the hemorrhage is Computed Tomography. Hypertensive hemorrhages appear on CT as areas of high density with sharply defined borders. There is typically only a single lesion that tamponades itself thus limiting its size. These areas tend to be homogenous unless there is active bleeding or a coagulopathy as would be seen in a hemorrhage associated with anticoagulant use. Edema develops over the course of days following the initial bleed causing an area of low attenuation to develop around the perimeter of the hemorrhage. Hemorrhages frequently extend into the ventricular system but subarachnoid hemorrhage is occasionally seen.

Patients with large hematoma usually have a decreased level of consciousness as a result of increased intracranial pressure and the direct compression or distortion of the thalamic and brainstem reticular activating system.[10] The presence of a large hematoma and ventricular blood increases the risk of subsequent deterioration and death 10. Similarly, a mass effect (midline shift) which results from the volume of the hematoma, the edematous tissue surrounding the hematoma, and obstructive hydrocephalus with subsequent herniation remains the chief secondary cause of death in the first few days after intracerebral hemorrhage.

According to previous studies, the mortality rate six months after spontaneous ICH ranges from 23 to 58 percent. A low score on the Glasgow Coma Scale, a large volume of the hematoma, and the presence of ventricular blood on the initial CT scan are factors that have been consistently identified as predictive of a high mortality rate.

Broderick et al found that the mortality rate at one month was best predicted by determining the initial score on the Glasgow Coma Scale and the initial volume of the hematoma 9. In their study, patients who initially had a score of less than 9 on the GCS and a hematoma volume of more than 60 ml had a mortality rate of 90 percent at one month, whereas patients with a score of 9 or greater and a hematoma volume of less than 30 ml had a mortality rate of 17 percent.

In another study by Mitra et al , age of more than 60 years, GCS of 6 or less (in a modified Scale of 10) at the time of admission, ICH volume greater than 30 ml, midline shift in CT scan of more than 3 mm and presence of intraventricular hemorrhage (IVH) and hydrocephalus had an adverse impact on outcome. Young age, GCS of more than 8, ICH volume of less than 20 ml, presence of lobar hemorrhage and absence of IVH/Hydrocephalus were associated with relatively favorable outcome.

Surgical treatment of patients with intracerebral hemorrhages must be individualized. Patients with accessible lobar hemorrhages who are deteriorating neurologically will often improve with surgery. Large dominant hemisphere basal ganglia lesions in elderly patients are probably not suitable candidates for surgery.

The decision to operate depends on the patient's neurological deficit, evidence of progression of the deficit, the location of the hemorrhage and an assessment of the neurological prognosis, given all these factors, by the treating physicians.

A meta-analysis of three randomized, controlled trials of supratentorial hemorrhage reported that, as compared with the 126 patients who did not undergo surgery, the 123 patients with an ICH who underwent surgical evacuation through an open craniotomy had a higher rate of death or dependency at six months (83 percent vs. 70 percent). Recent attempts at early craniotomy did not alter the outcome and were usually associated with an increased probability of recurrent bleeding.

This study was conducted to determine the predictors of mortality based on the CT scan finding of patient admitted due to hypertensive intracerebral hemorrhage at the Philippine Heart Center. Specifically, this study aimed to describe the socio-demographic and clinical profile of patients with hypertensive intracerebral hemorrhage as well as determine the association of hematoma volume, midline shift/herniation, intraventricular hemorrhage, subarachnoid hemorrhage and hydrocephalus with mortality among patients with HICH admitted at the PHC.

### Definition of Terms

1. Brain edema – represents moderate amount of bulk water within acute hematomas.
2. Computed Tomography – images a section or slice of the patient. This is accomplished by obtaining a series of different angular projections or views of the section. Unlike conventional tomography and radiography, x-rays do not pass through neighboring anatomy, only through the section of interest.
3. Glasgow Coma Scale (GCS) – tests level of consciousness by evaluating eye opening (4), verbal output (5) and motor responses (6). It is most useful for following a patient's neurologic condition over time with serial Glasgow coma scores (total score of 15).
4. Estimated hematoma volume – it is computed by getting the product of Lx W x AP x 0.523 where L is the number of slices showing hematoma on CT scan, W is the greatest transverse diameter of the bleed, AP is the greatest antero-posterior diameter of the hematoma perpendicular to W and 0.523 is a constant factor.
5. Hydrocephalus – refers to ventricular dilatation secondary to obstructed CSF flow, decreased CSF absorption, or a combination of both.
6. Hypertension – elevation of blood pressure. The Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure has classified hypertension according to the degree of BP elevation. Stage I patients have a systolic BP of 140 to 159 mm Hg or a diastolic BP of 90 to 90 mm Hg. Stage II individuals have a systolic BP of 160 to 179 mm Hg or a diastolic BP of 100 to 109 mm Hg, whereas Stage III (severe/accelerated hypertension) includes a systolic BP greater than or equal to 180 mm Hg or a diastolic BP greater than or equal to 110 mm Hg.
7. Hypertensive intracerebral hemorrhage – bleeding in the brain caused by high blood pressure.
8. Infarct – refers to subtle loss of gray-white differentiation and/or sulcal effacement on CT (seen in hyperacute stage) which eventually progresses to become a hypodense area (acute/subacute stage) which is limited to the major vascular territory rendered ischemic, with or without involvement of the adjacent border zone.
9. Intraventricular hemorrhage – presence of blood within the ventricular system which can be a complication of hypertensive hemorrhage or it can be due to trauma.
10. Midline shift – is the largest perpendicular distance between distance between an imaginary reference line joining the frontal crest and internal occipital protuberance, and the most shifted point of the septum pellucidum.
11. Subarachnoid hemorrhage – refers to extravasation of blood into the subarachnoid space, 80% of which is caused by ruptured aneurysms.

## Methods

This is a retrospective cohort study. The population studied consisted of all patients admitted at the Philippine Heart Center from the period of January 1, 2003 to December 31, 2004, who upon admission, cranial CT scan done revealed findings of hypertensive intracerebral hemorrhage. Included were all charts of patients in this study reveal admitting diagnosis of hypertensive intracerebral hemorrhage either managed medically or with surgical intervention. Excluded were the following: Patients with intracerebral bleed secondary to causes other than hypertension such as trauma, ruptures AV malformation/ aneurysm, tumoral bleed, or impaired coagulation; patients who were initially admitted at our hospital and with cranial CT scan done but eventually transferred to another hospital for further management and patients who were discharged against medical advice.

Prior to collation of data, a data collection form was made with three subdivisions, namely: A. Socio-demographic Profile, containing the name of patient, age, sex, status and occupation; B. Clinical Profile, which included # of years of hypertension, co-morbidities, GCS upon admission, presenting diagnosis at the E.R., management done, length of hospital stay, and outcome of patient, and finally; C. CT Scan Profile, which evaluated presence/absence of midline shift/herniation, estimated hematoma volume, other CT scan findings, serial CT scans (if there are any), and name of the CT reader (Radiologist).

The medical records/charts of 124 patients included in this study were retrieved from the records section of the Philippine Heart Center and by using the data collection form, the following variables were recorded: patient's name, age, sex, status, occupation, # of years of hypertension, co-morbidities, GCS upon admission, presenting diagnosis at the E.R., management done, length of hospital stay, and outcome/status at discharge.

### Data Extraction from the CT scan plates

All CT scan plates of 124 patients included in this study were retrieved from the filing area of the Radiology Department of PHC. The following data were collected: estimated hematoma volume, presence/absence of midline shift/herniation, other CT scan findings, serial CT scans done (if there are any), and name of the CT reader.

#### *Estimated Hematoma volume*

This is noted from the official CT scan readings and is computed by getting the product of L x W x AP x 0.523

#### *Assessment of Midline Shift*

By using a fine-pointed colored pencil (black) and a ruler, midline shift was measured by determining the largest perpendicular distance between an imaginary reference line joining the frontal chest and internal occipital protuberance, and the most shifted point of the septum pellucidum. By using a piece of paper with a straight edge, measurement was taken and placed parallel to a caliper beside the chosen scanogram and result was recorded. Since manual measurement was done (without the benefit of being exact), the researcher did two trials and she also asked one of her experienced consultant Radiologists to measure the midline shifts in a single trial. Average of the measurements was computed and was recorded in millimeter (mm). All data collected were placed in a master list and eventually used in statistical analysis.

## Results

A total of 124 patients' medical charts were reviewed. The socio- demographic and clinical profile is summarized in table 1.The youngest patient was 21 years old female who was a case of a intraparenchymal hemorrhage in the left basal ganglia and the oldest was 97 years old female a case a intracerebral hemorrhage in the right capsulothalamic region.

**Table 1.** Socio-demographic and Clinical Profile of ICH patients included in the study

| Characteristic | | Frequency (%) | Mean $\pm$ SD |
|---|---|---|---|
| Age | | | 60.161 $\pm$ 14.3 |
| Sex | | | |
| | Male | 71 (57%) | |
| | Female | 53 (43%) | |
| Status | | | |
| | Single | 11 (9%) | |
| | Married | 86 (70%) | |
| | Widow | 24 (20%) | |
| | Separated | 2 (2%) | |
| Occupation | | | |
| | Business | 26 (27%) | |
| | Employee | 24 (25%) | |
| | Retired | 47 (49%) | |
| Co-morbidities | | | |
| | Absent | 42 (33.9%) | |
| | Present | 82 (66.1%) | |
| Duration of Hypertension | | | |
| | Not known HPN | 35 (28.2 %) | |
| | < 2 years | 1 (0.8 %) | |
| | 2-5 | 28 (22.6 %) | |
| | 6-8 | 7 (5.6 %) | |
| | 9-10 | 20 (16.1%) | |
| | >10 | 33 (26.6%) | |
| Blood Pressure | (mmHg) | | |
| | Systolic | | 155.9 $\pm$ 37.5 |
| | Diastolic | | 87.29 $\pm$19.88 |
| Hospital Stay | (days) | | 10.0 $\pm$ 9.26 |
| Management | | | |
| | Medical | 108 (87.8%) | |
| | Surgical | 15 (12.2%) | |
| Outcome | | | |
| | Recovered | 82 (66.1%) | |
| | Died | 42 (33.9%) | |

The majority were males (57.3%) than females (42.7%), most were married (69.9%). Mostly were retired(48.5%) while others are employed (24.7%) or self-employed (26.8%). Sixty six percent (66 %) have co-morbidities. Among those with hypertension, the longest duration of hypertension was >10 years (26.6%). Our patients have all clinical diagnosis of hypertensive hemorrhage with a mean hospital stay of 10 + 9 days. There are about 87.8% cases who were managed medically as compared to 12.2 % surgical, with about 66.1% of the total sample remained alive or recovered while 33.9% died. In the CT scan profile (Table 2), we included the radiology findings such as hematoma volume, presence or absence of midline shift/herniation, intraventricular hemorrhage (IVH), subarachnoid hemorrhage (SAH) and presence of hydrocephalus. We manually computed the hematoma volume and it was found to have a mean of 35.7 ml. Independent predictors of mortality were determined using univariate and multivariate statistical analysis.

**Table 2.** CT Scan Profile of Patients with Intracerebral Hemorrhage Included in the Study

| CT Scan Finding | | Frequency (%) | Mean $\pm$ SD |
|---|---|---|---|
| Midline Shift/ Herniation | | | |
| | Present | 35 (28.2) | |
| | Absent | 89 (71.8) | |
| Hematoma volume (ml) | | | 35.70 $\pm$ 36 |
| Other Findings | | | |
| | Intracerebral Hemorrhage | 15 (30.6) | |
| | Subarachnoid Hemorrhage | 24 (49) | |
| | Hydrocephalus | 10 (20.4) | |

### Cranial CT Scan Findings Predictive of Mortality

We recorded the dependent variables as outcome: recovered=0, died=1, and the independent variables such as midline shift: NO=0, YES=1, hematoma volume as 0 =NO, 1=YES, and so with the other CT scan findings of intraventricular hemorrhage (IVH), subarachnoid hemorrhage (SAH) and hydrocephalus. We entered this variables in a univariate and multivariate analysis to obtain the p value (<0.05 significant result). Results show that among all the CT scan parameters only the presence of subarachnoid hemorrhage is strongly associated with mortality with p-value of 0.039 and Odds Ratio of 3.386.

**Table 3.** Clinical and CT scan predictors of Mortality among ICH patients

| | Recovered N=82 | Died N=42 | p-value |
|---|---|---|---|
| Age (mean, SD) | 58 (13.4) | 64 (15.3) | 0.033 |
| Male gender | 47 (57.3%) | 24 (57.1) | NS |
| Occupation | | | 0.028 |
| Business | 17 (20.7%) | 9 (21.4%) | |
| Employee | 20 (24.4%) | 4 (9.5%) | |
| Retired | 24 (29.3%) | 23 (54.8%) | |
| Presence of Co-morbidities | 53 (64.6%) | 29 (69%) | NS |
| Duration of Hypertension (mean, SD) | 8.5 (5.7) | 10.3 (5.5) | 0.029 |
| Systolic BP mmHg (mean, SD) | 153 (30.37) | 162.2 (48.5) | NS |
| Diastolic BP mmHg (mean, SD) | 87.53 (18.88) | 86.8 (22) | NS |
| Hospital Stay (mean, SD) | 12.8 (9.8) | 4.57 (4.62) | 0.000 |
| Management | | | NS |
| Medical | 70 (86.4%) | 38 (90.5) | |
| Surgical | 11 (13.6%) | 4 (9.5%) | |
| Presence of Midline Shift/ Herniation | 21(25.6%) | 14 (33.3%) | NS |
| Volume of Hematoma in mL (mean, SD) | N=19<br>38.65 (40.58) | N=9<br>29.44 (24.55) | NS |
| Other Findings | | | NS |
| Intraventricular Hemorrhage | 7 (30.4%) | 8 (30.8%) | |
| Subarachnoid Hemorrhage | 11 (47.8%) | 13 (50%) | |
| Hydrocephalus | 5 (21.7%) | 5 (19.2%) | |

## Discussion

Based on socio-demographic and clinical profile of patients, this study showed that the mean age of the patient population at the Philippine heart center who suffered from hypertensive hemorrhage from the period of January 1, 2005 to April 25, 2006 was 60.2 year. The youngest patient was 21 years old and the oldest patient was 97. Males were noted to be the more affected population than the females with a frequency of 57.3 vs. 42.7, respectively. In related studies, it was shown that 90% of patients with bleed are older than 45 years of age and with a 5-20% higher incidence in males than in females. It was also determined that most of the patients were married (69.9%), retired (48.5%), with co-morbidities (66.1%). Of the co-morbidities present, most of them have long standing hypertension. Chronic hypertension plays a major role since it is a main causative factor for spontaneous intracerebral hemorrhage.

Upon admission, our patient population (based on chart review) had a clinical diagnosis of hypertensive hemorrhage. To confirm the clinical diagnosis, all patient included in this study underwent cranial CT scan procedure with findings of hypertensive intracerebral hemorrhage (HICH) and for which statistical analysis eventually revealed mean hematoma volume of 35.7 ml, 15% intraventricular hemorrhage (IVH) , 19% subarachnoid hemorrhage (SAH) and 8% hydrocephalus. There is a presence of 28.2% midline shift on the sample population with 71.8% having no midline shift at all.

By subjecting the socio-economic and clinical profile of the patient into a univariate analysis (chi-square, p value) for predicting mortality in HICH, it was found out that age (p=0.033), and years of hypertension (p=0.029) are dependent predictors of mortality because both of them have p value <0.05. In the result obtained, although occupation (p=0.028) is statistically significant, it is not a good predictor of mortality because mostly who retired are of old age. Hospital stay (p=0.000) having a significant statistical value however, still is not considered a good predictor because those with shorter stay would likely mean that the patient expired already.

Using the CT scan profile of the patient and subjecting it to a univariate analysis only the presence of SAH (p=0.0358) shows strong association with mortality in HICH patients. Using all the predictors that gives statistically significant result (p=<0.05) in univariate analysis (age, years of hypertension, occupation, hospital stay and SAH ) and subjecting it to a multivariate analysis, only the presence of SAH showed a significant result [(p=0.039) Odds Ratio 3.386]. Thus, the presence of SAH in the CT scan findings of the patient with HICH gives a three times higher risk of mortality than those patient without

SAH.

The Glasgow Coma Scale (GCS) was included in the data collection form prior to actual data gathering, however the researcher found out that most of the medical records/ charts of the patients in this study did not contain GCS on admission, hence it was not included in the analysis.

## Recommendation

The author wants to emphasize the importance of GCS score of patients who present with neurological deficit at the emergency room be always recorded in the chart for its potential use in the future studies since it is one of the established independent predictors of mortality in HICH.

## Conclusion

In conclusion, using the univariate and multivariate analysis, the only strong predictor of mortality on CT scan findings among patient with hypertensive intracerebral hemorrhage admitted at the Philippine heart center is the presence of subarachnoid hemorrhage, having three times higher risk of dying compared to those patients without SAH in the CT scan result.

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