Prognostic factors and long-term outcomes of surgically treated acute SDH in a tertiary centre of developing country a prospective observational study

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Abstract

Backgrounds

Acute traumatic subdural hematoma (SDH) can be a life-threatening neurosurgical emergency that necessitates immediate evacuation. Predictor data for functional outcomes are scarce and mostly retrospective. The purpose of this prospective research is to evaluate the clinical presentation, risk factors, and final outcomes of SDH patients who underwent surgical intervention.

Methodology

A prospective observational study was conducted on a consecutive series of patients with surgically treated subdural hematoma (SDH) from November 2022 to March 2023. A comparison was made between individuals with favourable and unfavourable 3-month outcomes (as measured by the Glasgow Outcome Scale [GOS] 0–3 versus 4–5) in terms of baseline clinical data, hospital and surgical course, complications, and imaging data. A multivariable logistic regression model was developed in order to determine the independent predictors of good outcomes. The nomogram was constructed by applying the model.

Results

101 SDH patients were surgically managed and followed up for 3 months. The admission GCS, haemoglobin, BUN, presence of brain bulge, and other associated injuries were found to be significantly different between good and poor outcome patients. The presence of a brain bulge was found to be significant in the multivariate model. A score of 30 can ensure a good functional outcome with a 95% probability.

Conclusion

The authors anticipate that the findings from this study, conducted at a single institution are helpful in preoperative discussions with patients and their families. These insights specifically pertain to the anticipated postoperative outcomes following the surgical evacuation of SDH.

Introduction

One of the most typical neurological emergencies is an acute subdural hematoma (SDH). While there is a lack of comprehensive epidemiological data, previous investigations have found a prevalence of 11%-20% in patients with brain injury [1, 2]. Headache, psychiatric symptoms, cognitive impairment, seizures, and focal neurologic abnormalities are all possible SDH symptoms [3]. The death rate is in the range of 55 and 80 percent [4, 5]. It is unclear, if functional recovery has improved over the last decade [6, 7], despite the fact that healthcare utilisation has increased and mortality has decreased. The impact of baseline clinical features and hospitalisation occurrences on long-term functional recovery is little

understood. Therefore, the purpose of this prospective, observational study was to discover independent determinants of good functional outcome at 3 months in a surgically treated SDH group.

Material and methods

This is single-centric prospective study done at tertiary centre from November 2022 to March 2023. Subjects with or without additional intracranial/extracranial injuries who had surgical evacuation for posttraumatic acute SDHs were included in the analysis. Non-traumatic SDH as well as posttraumatic SDH treated conservatively during hospitalization were not included in the study. All participants had their parents or legal guardians or other responsible adults given the written and informed consent for the surgery. This study was approved by the Institute Ethical Committee. In accordance with the principles outlined in the Helsinki Declaration [8], the study was conducted.

All the related information was taken from medical record and departmental electronic data base. Patients' demographics, clinical presentation, and neurological condition were documented. The hematoma, mass effect, and other intracranial lesions were noted as per radiological images. The specifics surgical intervention, hospital stay, death, and day of discharge were recorded. In the follow-up period, the record of readmission, death, or transfer to a nearby facility were noted. Patients were checked on 3 months after surgery to assess how well they were functioning. All patients were treated in accordance with an established advanced trauma life support procedure. At presentation and throughout their hospital stay, the patient's level of consciousness was evaluated using the Glasgow Coma Scale (GCS)[9]. Computed tomography (CT) scans were performed on everyone who had even a remote possibility of having a history of head trauma. The conservative management was given for asymptomatic or neurologically stable patients and those who had minimal symptoms and an SDH of volume < 15 mL without mass effect who were hospitalized for 24 hours or more than 24 hours after the accident. The following criteria were used to select the patients for surgery:

a) Thickness of hematoma >10 mm or mid line shift >5mm

b) Thickness of hematoma < 10 mm and mid line shift <5 mm with anyone of the followings.

1. GCS drop by >/= 2 points from injury to admission

2. and /or asymmetric and or fixed and dilated pupil.

3. and/or ICP > 20 mm of Hg.

The three different surgical procedures were performed including craniotomy with fixing of the bone flap, burr hole and decompressive craniectomy as per indication. After surgery, everyone was kept in ICU. The CT scan was performed for all the postoperative patients within 12–24 hours after surgery. The patient was transferred to the general ward after extubation and stabilising the general conditions. The functional outcome was evaluated using the Glasgow Outcome Scale (GOS) score before the patient was allowed to go home. Patients were followed up at every three months telephonically to determine how

they were doing using the Glasgow Outcome Scale (GOS) Score. The GOS consists of a "structured interview with parents/guardians/patients regarding changes in function after injury in seven areas: consciousness, independence at home, independence outside the home, school or work, social and recreational activities, family and friends, and return to normalcy." An impartial writer, unaware of the hematoma's precise radiographic position, performed the interview. The outcomes of the GOS score were classified into “Good” and “Poor”, as shown in Table 1. This article's material and methodology are based on study done by Echara M et al [10].

Table 1
Interpretation of Outcome by GOS Scale at 3-month follow-up.

GOS scale	Score	Outcome
Good recovery	5	Good
Moderate disability	4	
Severe disability	3	Poor
Vegetative state	2	
Death	1	

Statistical analysis- The information was retrieved and then entered into a Microsoft Excel spreadsheet. SPSS version 26 software program and STATA 17 [11] were used for the analysis. Categorical variables were represented as proportions. Continuous variables were presented as median and interquartile range values. All parameters were tested for normality using Shapiro–Wilk. Mann–Whitney U-tests were used for continuous variables which were non-normally distributed and student t test were used for normally distributed continuous variables. Chi-square tests was used for categorical variables. GOS outcome was converted into binary categories using 1,2,3 as poor outcome and 4,5 as good outcome. It was coded as 1 for good outcome and 0 for poor outcome. Univariate logistic regression was run to assess the association between various categories. Correlation coefficients was also calculated. Variables which had higher correlation co-efficient (> 0.5) or had VIF of more than 5 or which caused Hosmer Lemeshow test [12] to become significant were dropped from the multivariable model. Multivariable logistic regression was run to assess the association between the factors and favourable GOS outcome. OR (Odd’s ratio) were reported with 95% confidence interval (C.I.) P value less than 0.05 was taken as significant. The logistic regression was performed in STATA 17 software. The nomolog command for normogram was used in STATA and checked through calibration and hosmer lemeshow test.

Results

Out of all 101 patients, the median age was 45.5 years (Range = 4–85) and 72.3% patients were males. The median GCS at admission was 11 (Range = 3–15). The loss of consciousness, vomiting and ENT

bleed were present in 67.3%, 59.4% and 49.6% of patients respectively. Seizure and midline shift (MLS) were present in 9.9% and 93.1% of patients respectively. The median MLS was 7.2 mm (Range = 1.1–20). In 92.1% of patients there was mass effect during the time of admission and 26.7% patients had brain bulge. 10.9% and 20.8% patients had hypotension and hypothermia respectively. During the time of discharge 57.4% had poor outcome. In Table 2, we compared the clinico-demographic profile as well as biochemical and radiological parameters between patients with good and poor outcome. Out of all the parameters, the value of GCS at admission as well as discharge, haemoglobin, blood urea nitrogen, creatinine and presence of brain bulge, other main injury, face injury, hypotension, inotropic support and good GOS at discharge were found to be significant. The GCS at admission was found to be 12 among the good outcome patients and 9 among the poor outcome patients. Similarly the GCS at discharge was significantly higher (GCS-15) among the patient with good outcome than the patients with poor outcome (GCS-11).

Table 2
– Comparison of biochemical parameters between good and poor clinical outcome at 3 months

Parameters	Poor outcome (GOS 1–3)	Good outcome (GOS 4/5)	p value
Age	40 (20–62)	40 (27–55)	0.857
Sex	63.6%	76.3%	0.402
Male	36.4%	23.7%	
Female			
GCS at admission	9 (3–12)	12 (11–13)	0.005*
Loss of consciousness	72.7%	57.9%	0.374
Vomiting	45.5%	65.8%	0.223
ENT bleeding	27.3%	39.5%	0.46
Seizure	9.1%	5.3%	0.641
Respiratory rate	21 (17–26)	18 (18–20)	0.113
Pulse rate	96 (57–107)	73 (69–90)	0.51
SBP	123 (96–154)	119.5 (116–133)	0.657
DBP	81.27 +/- 16.09	72.47 +/-13.62	0.076
Temperature of the body	98.2 (97.6–99.8)	98.05 (98-98.4)	0.507
Mid Line shift (MLS)	90.9%	92.1%	0.898
MLS size	7.25 (6–10)	7.2 (6.2-8)	0.806
Fracture on CT	36.4%	42.1%	0.733
Mass effect	90.9%	89.5%	0.89
Contusion	90.9%	65.8%	0.104
Brainstem injury	0%	15.4%	0.672
Presence of dot hemorrhage	18.2%	10.5%	0.495
Edema	72.7%	47.4%	0.138
Obliteraion of 3rd ventricles or basal cisterns effaced	100%	92.1%	0.336

LOC- Loss of consciousness, MLS – Mid line shift, SAH – Sub arachnoid haemorrhage

Parameters	Poor outcome (GOS 1–3)	Good outcome (GOS 4/5)	p value
Traumatic SAH	45.5%	18.9%	0.074
IVH	9.1%	2.6%	0.34
Evacuated hematoma	100%	97.4%	0.587
EDH			
Brain bulge	63.6%	5.3%	0.001*
Other major injury	45.5%	15.8%	0.038*
Chest injury	40%	16.7%	0.387
Face injury	0%	66.7%	0.035*
Spine injury	20%	16.7%	0.887
Extremities / long bone fracture	40%	0%	0.087
Hypotension	18.2%	2.6%	0.058*
Hypertension	18.2%	18.4%	0.986
Hypothermia	18.2%	13.2%	0.675
Inotropic support	18.2%	2.6%	0.058*
Hemoglobin (g/dl)	10.59 +/- 1.03	11.8 +/- 1.92	0.01*
Sodium (mEq/L)	137 (129–141)	137 (135–139)	0.571
Hematocrit (g/dl)	32 (29–39)	33 (30–35)	0.792
Potassium (mEq/L)	3.7 (3.2-4)	3.8 (3.7-4)	0.112
Blood urea nitrogen (mg/dl)	18.35 (11-25.6)	30.3 (28-33.9)	0.007*
RBC	4.29 +/- 2.44	3.91 +/- 0.71	0.617
Platelet (lacs/cubic mm)	148 (82–221)	163.5 (135–181)	0.518
Creatinine (mg%)	0.6 (0.5–0.7)	0.7 (0.6–0.8)	0.035*
pCO2 (mm of Hg)	31 (20–46)	32.65 (29.2–36)	0.684
WBC (/ cubic mm)	10 (4.5–20)	10.95 (9.6–13.1)	0.675

LOC- Loss of consciousness, MLS – Mid line shift, SAH – Sub arachnoid haemorrhage

Parameters	Poor outcome (GOS 1–3)	Good outcome (GOS 4/5)	p value
Glucose level (mg%)	122 (109–202)	117.5 (112–129)	0.719
pO2 (mm of Hg)	189 (63–308)	198 (107-239.2)	0.765
Calcium (g/dl)	8 (7.1–8.9)	8.65 (8.4–8.9)	0.071
HCO3 (mmol/L)	21 (13–25)	20 (18.8–22)	0.737
pH	7.4 (7.3–7.4)	7.4 (7.3–7.4)	0.078
GCS at discharge	11 (8–14)	15	0.001*
GOS at discharge (good-GOS 4/5)	0%	86.8%	0.001*
LOC- Loss of consciousness, MLS – Mid line shift, SAH – Sub arachnoid haemorrhage			

The mean value of haemoglobin was 10.59+/-1.03 g/dl among the poor outcome patients and 11.8+/-1.92 g/dl among the good outcome patients. The value of blood urea nitrogen was 18.35(11-25.6) mg/dl and 30.3(28-33.9) mg/dl among the patients with poor and good outcome respectively. The value of creatinine was significantly higher among the patients with good outcome (0.7(0.6-0.8) mg%) than poor outcome (0.6(0.5-0.7) mg%). A significantly higher proportion (63.6%) of patients with poor outcome had brain bulge. Only 5.3% patients with good functional outcome had brain bulge. 45.5% patients with poor outcome had other major injury while 15.8% patients with good outcome had major injury. No patients with poor outcome had face injury while 66.7% patients with good outcome had face injury. 18.2% poor outcome patients required inotropic support and 2.6% of the good outcome patients required that. None of the patients with poor outcome at 3 months had good GOS at the time of discharge whereas 86.8% of the good outcome patients had good GOS at the time of discharge. Table 3 showed that patients who had undergone craniectomy had 0.23 times lower odds for favourable GOS compared to those who were not underwent for the craniectomy.

Table 3

Univariate analysis of parameters predicting good outcome. LOC- Loss of consciousness, MLS – Mid line shift, SAH – Sub arachnoid haemorrhage

Parameters	Odd's ratio	p value
Female	0.54	0.405
Absence of LOC	1.93	0.379
Absence of vomiting	0.43	0.229
Absence of ENT bleeding	0.575	0.463
Absence of seizure	1.8	0.645
Presence of MLS	1.17	0.899
Fracture	1.27	0.733
Mass effect	0.85	.89
Contusion	0.19	0.135
Dot hemorrhage	0.53	0.5
Edema	0.34	0.148
Traumatic SAH	0.27	0.076
Craniotomy	1.39	0.666
Burr hole (evacuation)	2.49	0.205
Craniectomy	0.23	0.043*
Brain bulge	0.03	0.001*
Major injury	0.23	0.047*
Spine injury	0.27	0.37
Hypotension	0.12	0.1
Hypertension	1.02	0.986
Hypothermia	0.68	0.676
Inotropic support	0.12	0.1
Age	0.99	0.871
GCS at admission	1.39	0.005*
Respiratory rate	0.92	0.156
Pulse rate	0.99	0.479

Parameters	Odd's ratio	p value
SBP	1.01	0.495
DBP	0.96	0.086
Temperature	0.71	0.393
SpO2	0.99	0.924
MLS size	0.99	0.886
Hemoglobin (g/dl)	1.56	0.062
Sodium (mEq/L)	1.07	0.345
Hematocrit (g/dl)	0.98	0.767
Potassium (mEq/L)	4.14	0.107
Blood urea nitrogen (mg/dl)	1.09	0.031*
RBC	0.82	0.409
Platelet (lacs/cubic mm)	1.001	0.798
Creatinine (mg%)	48.74	0.087
pCO2 (mm of Hg)	0.98	0.503
WBC (/ cubic mm)	1.03	0.65
Glucose level (mg%)	1.001	0.801
pO2 (mm of Hg)	1.001	0.813
Calcium (g/dl)	1.12	0.483
HCO3 (mmol/L)	0.98	0.731
pH	1.05e-06	0.08

This association was statistically significant in the univariate logistic model. Patients with brain bulge was negatively associated with favourable GOS at discharge with OR of 0.03. Participants with history of other major injury have 0.23 times lower odds for favourable GOS compared to those patients without such associated injuries. This association was statistically significant in the univariable logistic model. For each unit increase in GCS there was 1.39 times increase in the odds of favourable GOS (statistically significant). For each unit increase in blood urea nitrogen there was 1.09 times increase in the odds of favourable GOS which was found to be statistically significant. In the multivariable logistic model only presence of brain bulge during admission was found to be significantly associated with the favourable

GOS at 3 months as shown in Table 4. There were 0.02 times lower odds for favourable GOS among those who had brain bulge compared to those in whom no brain bulge was found.

Table 4
Multivariate analysis for GOS favourable outcome at 3 months (Pseudo R square = 0.48, p value = 0.001).LOC- Loss of consciousness, MLS – Mid line shift, SAH – Sub arachnoid haemorrhage

Parameters	Odd's ratio	p value
Female	0.33	0.367
Absence of LOC	3.39	0.437
Absence of vomiting	0.17	0.304
Fracture	12.94	0.244
EDH	2.42	0.54
Edema	0.08	0.099
Traumatic SAH	0.25	0.507
Burr hole (evacuation)	6.2	0.308
Craniotomy	9.08	0.161
Brain bulge	0.02	0.028*
Major injury	2.86	0.637
Hypertension	0.8	0.893
Hypothermia	3.4	0.624
MLS size	1.07	0.742
pO2 (mm of Hg)	0.99	0.923

In Fig. 1, the scores for each variable as per their individual value and at the end the probability for favourable GOS are given (probability ranging from 0 to 1). Only variable fitting the logistic model and calibrating with non-significant Hosmer Lemeshow test were put in the model.

Discussion

This work was one of the initial attempts, based on our current understanding, to provide a comprehensive analysis of prospective, extended-term functional outcomes over a three-month period for a sequential series of patients diagnosed with acute subdural hematoma (SDH). Another notable

advantage of this study was the absence of confounding factors such as the discontinuation of life-sustaining care and the inclusion of ill patients, as these individuals were deliberately excluded. This deliberate exclusion served to restrict the interpretation of other studies that evaluated mortality as a primary outcome [13, 14].

The majority of the patients in our study were male, accounting for 72.3% of the total sample. This finding suggested a natural inclination among males to exhibit behaviours associated with violence, as indicated by previous research [15–21]. Nevertheless, no notable disparity was observed in the distribution of gender and age between those with favourable and unfavourable outcomes. Patients who fared well in our study had considerably higher GCS values both at admission and at discharge. The GCS at admission was found to be significant in univariate analysis. Older age, poor premorbid functional status, and poor admission neurological status had all been proven to independently predict a poor 3-month functional outcome in earlier research. According to the research of others [22, 23], the key determinants predicting outcome after traumatic brain injury with acute SDH were the patient's age, the severity of the damage, and the patient's neurological status upon admission. The presence of a brain bulge or other severe injuries was revealed to be statistically significant in our study when analysed using a univariate method. Our results were consistent with those of the prior research.

A large proportion of patients with a good 3-month functional outcome had facial injuries, a finding that was found to be statistically significant. To the best of our knowledge, there was no existing study that had examined the impact of facial injuries on the functional outcome of patients with acute subdural hematoma who undergo surgical management. This finding's most likely explanation was the prompt provision of airway assistance to facial injury patients. The cardiovascular condition of patients at admission, along with their hospital progression, significantly influences the long-term functional outcome of subdural hematoma (SDH) patients. Previous research indicated that the occurrence of comorbidities, specifically hypertension and hypotension during admission, as well as the administration of vasopressor medication, exhibited notable disparities between patients with favourable and unfavourable outcomes.

Additionally, it was discovered that a majority of the patients who experienced hypotension and necessitated the administration of vasopressors to sustain cardiovascular stability exhibited unfavourable results during the 3-month follow-up period [10, 24]. In the present investigation, our findings revealed a degree of resemblance between the outcomes observed for hypotension and the administration of vasopressor agents. The poor functional outcome group had a notably greater number of patients experiencing hypotension and receiving vasopressors. However, upon conducting univariate analysis, these two characteristics did not demonstrate statistical significance. The etiology of the hypotension may be associated with an additional significant trauma resulting in haemorrhage. In our investigation, in contrast to the aforementioned findings, there was no significant difference observed in the prevalence of hypertension between patients with good outcomes and those with poor outcomes.

Our research has analysed biochemical indicators between patients with good and bad functional outcome at 3 months post-surgery. There was no study comparing biochemical parameters to the functional outcome of SDH patients that we were aware of. Patients who fared well showed considerably greater levels of haemoglobin, blood urea nitrogen, and creatinine. Anaemia is a measure of both the presence of other, more serious medical conditions and the body's ability to withstand them. In some studies, it was found that patients with a preoperative haemoglobin of less than 10.0g/dL on admission were found to have a lower 6-month functional score on the Hip Handicap Impact Scale (HHS), Postoperative Mobility Scale (PMS), and SF-36 Rating of Physical Function and Physical Functioning [25]. Similar findings concerning anaemia were discovered in our investigation. There was no statistically significant difference in haematocrit between the patients who fared well and those who did not. This suggested that severe trauma or haemorrhage causing intravascular volume loss manifested as anaemia in patients with a poor outcome.

The creatinine levels observed in both groups fell within the established normal range. However, the blood urea levels were found to be elevated in the group of patients who experienced a favourable outcome. The variable was also determined to be statistically significant in univariate analysis, exhibiting a positive odds ratio in predicting a favourable outcome. Based on the available information, there was no study on the correlation between blood urea nitrogen (BUN) levels and functional outcomes in patients with subdural hematoma (SDH). Nevertheless, a study examining acute ischemic stroke revealed a positive association between the BUN/Cr ratio and the three-month outcome. Similarly, another study focusing on intracerebral haemorrhage discovered that an increased BUN:creatinine ratio served as an independent predictor of mortality within 30 days [26, 27].

We developed a nomogram to predict good functional outcome at 3 months follow up. There was 95% probability of having good functional outcome if a patient had a score of 30 and there was 10% probability of having good functional outcome if a patient had a score of 15.

Limitations:

1. Smaller sample size limits us in generalizing the results.
2. We appreciate that the follow up period should have been more for better interpretation of results.
3. In order to determine the viability of the nomogram, it is crucial to conduct extensive, multicentre research. This will increase the model's chances of widespread acceptance.

Conclusion

GCS at admission, brain bulge, presence of other significant injuries, craniectomy, and BUN were all related with the functional outcome after ICU admission for SDH. Identifying the patient characteristics or events most likely to result in improved functional recovery had far-reaching implications for patient treatment after the hospital stay.

Declarations

Source of funding

All authors have no source of funding to disclose.

Declaration of competing interest

All authors have nothing to disclose.

Ethical approval

This study involves human participants and was approved by Institutional research committee (IRC) (AIIMS/Pat/IRC/2021/834) and institutional ethical committee (IEC) (AIIMS/Pat/1EC/2020/834) of All India Institute of Medical Sciences, Patna. All procedures were performed in accordance with the Declaration of Helsinki.

Consent

Written informed consent was obtained from all the participants for publication of accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Data availability statement*:* The data that support the findings of this study are available from the corresponding author, Dr Anil Kumar, upon reasonable request.

Authors' contributions:

Conception or design of the work: Dr Anil Kumar and Dr Mainak Sinha

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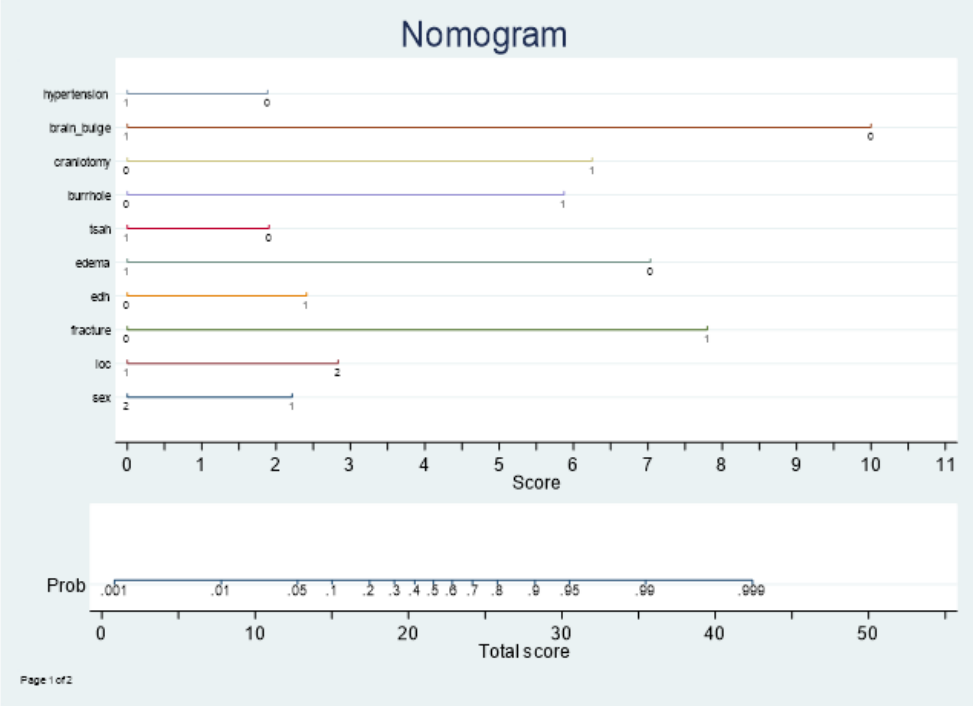
Figures



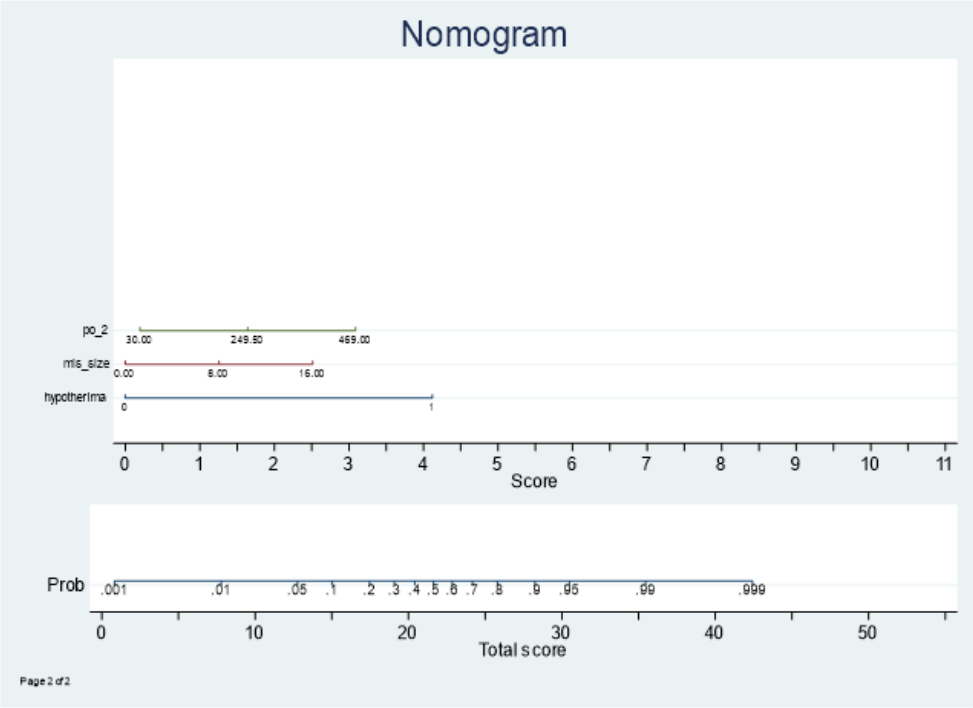


Figure 1

Nomogram for favourable GOS favourable (GOS 4,5) / unfavourable (GOS 1,2,3) at 3 months

(Sex- 1=male,2=female; Hypertension/Brain bulge/Craniotomy/Burr hole/tSAH/Edema/EDH/Fracture/Hypothermia -0=absent,1=present; LOC-1=yes,2=no)