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Evaluating the Clinical Significance of ICH Score in the Management of Intracerebral Hemorrhage: A Prospective Study in Karnataka, India

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Abstract: ***Background: Intracerebral hemorrhage (ICH) occurs mainly as a result of hypertension, trauma, arteriovenous (AV) malformations and tumours. Depending on the etiology of hemorrhage, ICH score components like GCS, CT brain findings such as volume of bleed, the presence of intraventricular hemorrhage (IVH) and infratentorial hemorrhage (ITH), the treatment varies. Methods: A prospective observational study was done on 30 patients with spontaneous and traumatic ICH at SDM medical college, Karnataka, India. The patients were assessed by brief history and ICH score parameters ie. GCS, CT brain findings such as ICH volume, IVH and ITH. Medical management or neurosurgical intervention was followed up. Predicted mortality by ICH score was compared with 30 day mortality. Results: Out of 30 patients subjected to study 53.3% had traumatic ICH and 46.7% had spontaneous ICH with one sided weakness. 5 patients with traumatic ICH underwent neurosurgery. No patients with spontaneous ICH underwent neurosurgery. Among all patients with ICH managed medically, predicted mortality was 40% but actual mortality was 16% and in patients underwent neurosurgery, predicted mortality was 80% and actual mortality was 20% thus signifying the necessity of appropriate medical or surgical management of ICH.***

Keywords: Arteriovenous malformations, GCS, ICH, ITH, IVH

1. Introduction

Intracerebral haemorrhage (ICH) is the most prevalent type of stroke after ischemic stroke.[1]About 10 to 20 % of total incidence of stroke is intracerebral hemorrhage.[2,3] Intracerebral haemorrhage is bleeding in brain parenchyma due to rupture of blood vessels.[4] Intracerebral haemorrhage can be spontaneous or traumatic in onset. The most common causes of spontaneous intracerebral haemorrhage are hypertension, arteriovenous malformations, aneurysmal rupture, cerebral amyloid angiopathy, intracranial neoplasm, cerebral venous thrombosis, coagulopathy, sympathomimetic drug abuse, vasculitis etc. [1,5-10] Also intracerebral abuse, vasculitis etc.[1,5-10]Also intracerebral haemorrhage can occur secondary to trauma, infection and hemorrhagic transformation of infarct.[1,11-13] Common sites of spontaneous intracerebral haemorrhage are putamen and adjacent internal capsule, central white matter of temporal lobe and thalamus.[14]

2. Aims and Objectives

The study aims to:

- Stratify the risk of intracerebral hemorrhage
- Know the usefulness of ICH score in guiding the management of intracerebral hemorrhage and setting the treatment protocols
- Predict the 30 day mortality based on ICH score
- Evaluate the actual mortality comparing with the predicted 30 day mortality by ICH score

3. Role of ICH Score in Guiding the Management of Intracerebral Hemorrhage

ICH score is a prognostic tool and risk stratification scale considering factors related to neurological evaluation (GCS), age of the patient, intracerebral haemorrhage volume, intraventricular hemorrhage and infratentorial

Table 1: The ICH score[15]

ICH Score components	ICH Score
GCS Score	
3-4	2
5-12	1
13- 15	0
ICH Volume (cm3)	
≥ 30	1
< 30	0
IVH(Intraventricular Hemorrhage)	
PRESEN T	1
ABSENT	0
ITH (Infratentorial Hemorrhage)	
PRESENT	1
ABSENT	0
AGE in years	
≥ 80	1
< 80	0
Total ICH score	0-6

Table 2: ICH SCORE mortality prediction criteria[17]

ICH SCORE	Predicted Percentage of 30 day mortality
0	0%
1	13%
2	26%
3	72%
4	97%
5 &6	100%

haemorrhage assessed by neuroimaging.[15] The need of ICH score is to rapidly diagnose and effectively manage either medically or by neurosurgical intervention for the patients presenting to ED with intracerebral haemorrhage.[15,16]

If volume of bleed is less than 30 ml and if the bleed is in gangliocapsular region medical management has proven effective where as if bleed is more than 30 ml and if GCS of the patient is deteriorating then it should be intervened by neurological surgery. Intracerebral haemorrhage associated with tumours or AV malformations are generally intervened by neurosurgery.[16]

Various components of ICH score influence the outcome as given below.

- Patients having GCS score ≥13 proved better long term prognosis.[15]
- Age is considered as independent predictor of ICH outcome
- ICH volume is also associated with outcome but it is not an independent predictor because small hemorrhage of infratentorial origin in brainstem or cerebellum is associated with worse consequence hence requiring immediate diagnosis and further suitable line of management.[18]
- IVH associated hydrocephalus will provide extra prognostic guidance.[16]
- The presence of IVH and ITH will influence 30 day mortality.[15]

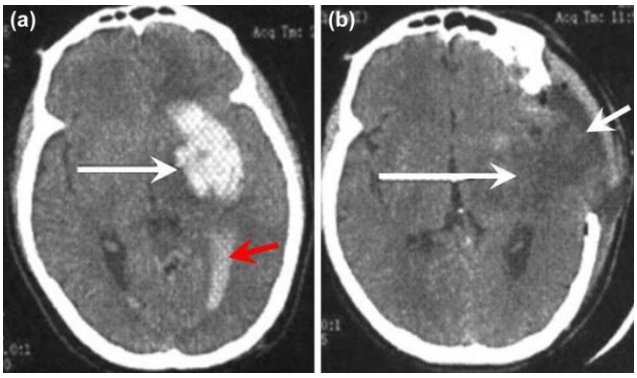
3.1 Emergency management of ICH

Being a neurological emergency, patients with ICH should be evaluated by airway, breathing, circulation along with signs of raised intracranial pressure. Endotracheal intubation should be done when there is risk of aspiration or impending respiratory failure. Intracranial pressure (ICP) control measures include 20% mannitol, head end elevation and hyperventilating the patient. These measures are given prior to definitive neurosurgical intervention. The management of hypertension in intracerebral hemorrhage is to maintain a mean arterial pressure (MAP) below 130 mmHg and cerebral perfusion pressure should be maintained more than 70 mmHg. Patients with coagulopathy due to medications should be given appropriate reversal agents. Risk of seizures after ICH is about 8% within 30 days hence antiepileptics should be given.[19] Management of haemorrhage with acute hydrocephalus via external ventricular drain is helpful for ICP measurement and cerebrospinal fluid (CSF) diversion resulting in reduced mortality in patients with intraventricular haemorrhage.[20-22]

Small bleed in the basal ganglias with no evident neurological deficits should be treated medically. Elderly patients with poor neurological state with large lobar hematomas, surgery is not proven beneficial but patients suffering from medium sized lobar ICH often requires surgery especially if GCS is below 7.[23]

3.2 Open surgery for ICH [24]

After general anesthesia, the neurosurgeons can remove the bone flap and open the dura matter in the hematoma location. The hematoma is evacuated to the extent possible. A drainage tube is inserted in the residual hematoma or subdural region. External ventricular drain is also placed in intraventricular haemorrhage prior to craniotomy. After ensuring there is no bleeding, an intracranial pressure probe is placed in the ventricles, the skin is sutured with fixation of drainage tube. The patients can be shifted to the neurosurgery intensive care unit (NICU) after surgery. The drainage tube is removed based on the volume of drainage within 24–72 hours. CT scan shall be repeated three days after surgery.[24]



Craniotomy done for Evacuation of Bleed

4. Materials and Methods

Ethical clearance was obtained from the institutional ethics committee. A prospective observational study was done on human subjects after obtaining consent from the patient.30 patients with traumatic and spontaneous intracerebral hemorrhage admitted to Emergency Medicine Department at SDM Medical College, Dharwad, Karnataka, India were subjected to study. The study was conducted during a period of 12 months from 1st April 2022 to 31st March 2023. Simple sampling was used in patient selection. Patients with age more than 18 years were included in the study. Patients were assessed by brief history, ICH score parameters like GCS and CT brain findings including ICH volume, IVH and ITH. The follow up of these patients were carried out either by conservative management with medications including antiepileptics and antiedema measures or by neurosurgical intervention have been adopted and also 30 day actual mortality was compared with predicted mortality by ICH score. Analysis was done with SPSS software version 2020. Pvalue < 0.05 is considered as statistically significant correlation

5. Results

30 patients with traumatic and spontaneous intracerebral hemorrhage were subjected to study. Age of patients in this study was above

Table 3: Summary of All Parameters

All Parameters	Mean ± SD || Median (IQR) || Min-Max OR N (%)
Age (<80)	30 (100.0%)
Clinical Presentation	
Trauma	16 (53.3%)
One Sided Weakness	14 (46.7%)
GCS	9.87 ± 4.64 || 10.00 (5.00-14.75) || 3.00 - 15.00
GCS Category	
3 to 4	4 (13.3%)
5 to 12	13 (43.3%)
13 to 15	13 (43.3%)
ICH Score	2.47 ± 1.14 || 2.00 (2.00-3.00) || 1.00 - 5.00
ICH Scoring	
Score0 – 1	7 (23.3%)
Score 2	9 (30.0%)
Score 3	8 (26.7%)
Score 4	5 (16.7%)
Score 5-6	1 (3.3%)
ICH Volume	
<30 cc	8 (26.7%)
>30 cc	22 (73.3%)
Infratentorial Hemorrhage (Yes)	4 (13.3%)
IVH (Yes)	17 (56.7%)
Management	
Conservative	25 (83.3%)
Neurosurgical Intervention	5 (16.7%)
Predicted Mortality Risk (%)	49.53 ± 33.31 || 26.00 (26.00-72.00) || 13.00 - 100.00
Predicted Mortality (Yes)	14 (46.7%)
Actual Mortality (Yes)	5 (16.7%)

18 years. Out of them 16(53.3%) patients had traumatic ICH and 14 (46.7%) patients had spontaneous ICH with one sided weakness. Distribution of patients with varying GCS, ICH volume, IVH, ITH and ICH score are given below. Also the distribution of patients with conservative management and neurosurgical intervention are mentioned in this table.

Table 4: Association between ICH Scoring and Parameters of ICH score

Parameters	ICH Scoring					p value
	Score 1 (n = 7)	Score 2 (n = 9)	Score 3 (n = 8)	Score 4 (n = 5)	Score 5&6 (n = 1)	
Age (<80)	7 (100.0%)	9 (100.0%)	8 (100.0%)	5 (100.0%)	1 (100.0%)	1.000[1]
Clinical Presentation						0.576[2]
Trauma	2 (28.6%)	6 (66.7%)	4 (50.0%)	3 (60.0%)	1 (100.0%)	
One Sided Weakness	5 (71.4%)	3 (33.3%)	4 (50.0%)	2 (40.0%)	0 (0.0%)	
GCS* **	14.43 ± 0.53	12.56 ± 3.57	6.00 ± 2.20	6.20 ± 3.27	3.00 ± 0	0.001[3]
GCS Category* **						<0.001[2]
3 to 4	0 (0.0%)	0 (0.0%)	2 (25.0%)	1 (20.0%)	1 (100.0%)	
5 to 12	0 (0.0%)	3 (33.3%)	6 (75.0%)	4 (80.0%)	0 (0.0%)	
13 to 15	7 (100.0%)	6 (66.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
ICH Score* **	1.00 ± 0.00	2.00 ± 0.00	3.00 ± 0.00	4.00 ± 0.00	5.00 ± 0	<0.001[3]
ICH Volume						0.576[2]
<30 cc	3 (42.9%)	3 (33.3%)	2 (25.0%)	0 (0.0%)	0 (0.0%)	
>30 cc	4 (57.1%)	6 (66.7%)	6 (75.0%)	5 (100.0%)	1 (100.0%)	
Infratentorial Hemorrhage (Yes)* **	0 (0.0%)	0 (0.0%)	1 (12.5%)	2 (40.0%)	1 (100.0%)	0.019[2]
IVH (Yes)* **	0 (0.0%)	7 (77.8%)	4 (50.0%)	5 (100.0%)	1 (100.0%)	0.001[2]
Management						0.312[2]
Conservative	6 (85.7%)	9 (100.0%)	6 (75.0%)	3 (60.0%)	1 (100.0%)	
Neurosurgical Intervention	1 (14.3%)	0 (0.0%)	2 (25.0%)	2 (40.0%)	0 (0.0%)	
Predicted Mortality Risk (%)* **	13.00 ± 0.00	26.00 ± 0.00	72.00 ± 0.00	97.00 ± 0.00	100.00 ± 0	<0.001[3]
Predicted Mortality (Yes)* **	0 (0.0%)	0 (0.0%)	8 (100.0%)	5 (100.0%)	1 (100.0%)	<0.001[2]
Actual Mortality (Yes)* **	0 (0.0%)	0 (0.0%)	1 (12.5%)	3 (60.0%)	1 (100.0%)	0.003[2]

****Significant at p<0.05, 1: Chi-Squared Test, 2: Fisher's Exact Test, 3: Kruskal Wallis Test*

As ICH score increases the scope of conservative management with medication reduces. From this analysis it is also inferred that the necessity of neurosurgical intervention is more in patients with high ICH score

Table 5: Association between Management and Parameters of ICH score

Parameters	Management		p value
	Conservative (n = 25)	Neurosurgical Intervention (n = 5)	
Age (<80)	25 (100.0%)	5 (100.0%)	1.000[1]
Clinical Presentation* **			0.045[2]
Trauma	11 (44.0%)	5 (100.0%)	
One Sided Weakness	14 (56.0%)	0 (0.0%)	
GCS	10.16 ± 4.74	8.40 ± 4.28	0.446[3]
GCS Category			0.307[2]
3 to 4	4 (16.0%)	0 (0.0%)	
5 to 12	9 (36.0%)	4 (80.0%)	
13 to 15	12 (48.0%)	1 (20.0%)	
ICH Score	2.36 ± 1.11	3.00 ± 1.22	0.228[3]
ICH Scoring			0.312[2]
Score 0-1	6 (24.0%)	1 (20.0%)	
Score 2	9 (36.0%)	0 (0.0%)	
Score 3	6 (24.0%)	2 (40.0%)	
Score 4	3 (12.0%)	2 (40.0%)	
Score 5-6	1 (4.0%)	0 (0.0%)	
ICH Volume			0.287[2]
<30 cc	8 (32.0%)	0 (0.0%)	
>30 cc	17 (68.0%)	5 (100.0%)	
Infratentorial Hemorrhage (Yes)	2 (8.0%)	2 (40.0%)	0.119[2]
IVH (Yes)	15 (60.0%)	2 (40.0%)	0.628[2]
Predicted Mortality Risk (%)	45.40 ± 32.21	70.20 ± 34.33	0.228[3]
Predicted Mortality (Yes)	10 (40.0%)	4 (80.0%)	0.157[2]
Actual Mortality (Yes)	4 (16.0%)	1 (20.0%)	1.000[2]

****Significant at p<0.05, 1: Chi-Squared Test, 2: Fisher's Exact Test, 3: Wilcoxon-Mann-Whitney U Test*

Of total 30 patients 25 patients were conservatively managed with medications and 5 patients underwent neurosurgical intervention. Of the 25 patients with medical line of management, 11 (44%) patients were traumatic ICH and 14 (56%) were spontaneous ICH with one sided weakness. 5 patients who underwent neurosurgical intervention were traumatic ICH. No patients with spontaneous ICH underwent neurosurgery. 48% patients with GCS score of 13 to 15 underwent medical management. 0 patients with GCS Score of 3 to 4 had undergone neurosurgical intervention where as 80% patients with GCS score of 5 to 12 had undergone neurological surgery hence proving that with worsening GCS especially for traumatic ICH neurosurgery is better way of management. It was also found 24% patients with ICH score of 0 to 1 had undergone medical management, 36 % with score 2 had undergone medical management, 24% with score 3 had undergone medical management, 12% with score 4 had undergone medical management and 4% with score 5 to 6 had undergone medical management where as 40 % patients with score 3 and 4 each had undergone neurosurgical intervention. Hence proving patients with high ICH score often require neurological surgery. 68% of patients managed medically was with volume of bleed more than 30 ml. Of the total patients managed by neurosurgery, all patients had volume of bleed greater than 30 ml. Percentage of patients with IVH and ITH undergone medical management and neurosurgery are also mentioned in above table. Predicted mortality for patients undergoing medical management by ICH score was 40% and actual mortality was 16% and predicted mortality for patients undergoing neurosurgical intervention was 80% and actual mortality was 20% signifying the necessity of appropriate medical or surgical management in patients with intracerebral haemorrhage.

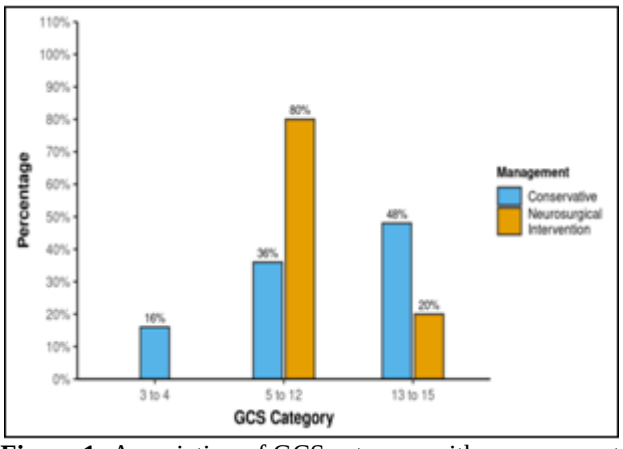


Figure 1: Association of GCS category with management

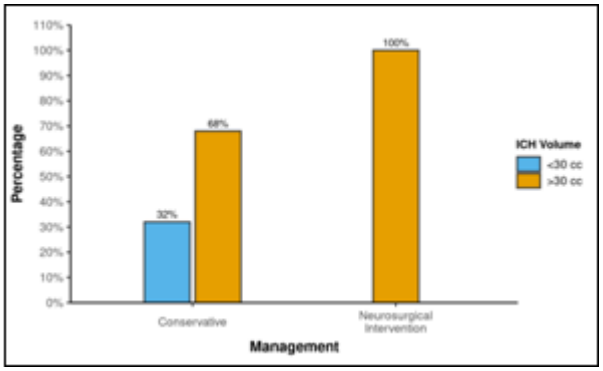


Figure 2: Association between ICH volume and management

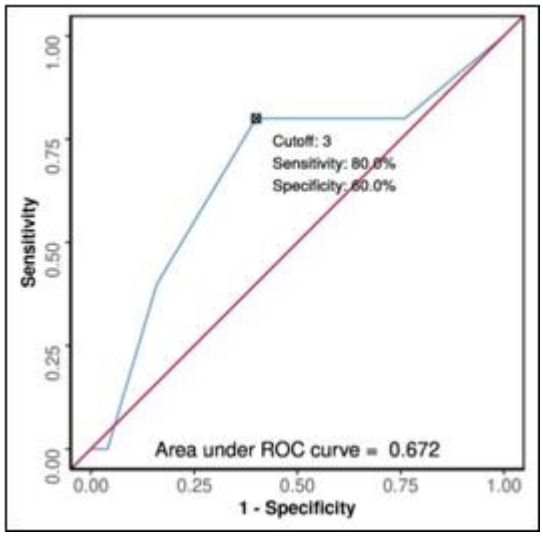


Figure 3: ROC Curve Analysis Showing Diagnostic Performance of ICH Score in Predicting Management

Parameter	Value (95% CI)
Cutoff (p value)	≥ 3 (0.228)
AUROC	0.672 (0.373 - 0.971)
Sensitivity	80.0% (28-99)
Specificity	60.0% (39-79)
Positive Predictive Value	28.6% (8-58)
Negative Predictive Value	93.8% (70-100)
Diagnostic Accuracy	63.3% (44-80)
Positive Likelihood Ratio	2 (1.04-3.83)
Negative Likelihood Ratio	0.33 (0.06-1.98)
Diagnostic Odds Ratio	6 (0.58-61.84)

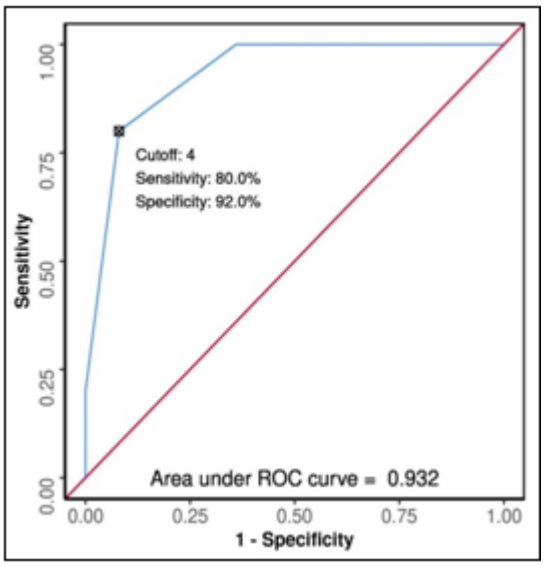


Figure 4: ROC Curve Analysis Showing Diagnostic Performance of ICH Score in Predicting Actual Mortality

Parameter	Value (95% CI)
Cutoff (p value)	≥ 4 (0.002)
AUROC	0.932 (0.839 - 1)
Sensitivity	80.0% (28-99)
Specificity	92.0% (74-99)
Positive Predictive Value	66.7% (22-96)
Negative Predictive Value	95.8% (79-100)
Diagnostic Accuracy	90.0% (73-98)
Positive Likelihood Ratio	10 (2.47-40.54)
Negative Likelihood Ratio	0.22 (0.04-1.26)
Diagnostic Odds Ratio	46 (3.33-634.88)

6. Discussion

Risk stratification scales like ICH score play a significant role in the evaluation and management of patients with traumatic and spontaneous ICH.[25-29]

The utility of this grading scale is to provide a standard evaluation tool that can be easily and quickly determined by physicians without expert training in neurology which enables consistency in communication and treatment.[15]

In this study all the 5 patients who underwent neurosurgical intervention had the volume of bleed assessed by CT brain as more than 30 ml. In our study 80 % patients with GCS 5 to 12 had undergone neurosurgical intervention where as only 20 % with GCS 13 to 15 have undergone neurosurgery indicating that neurosurgical intervention is required with deteriorating GCS.[16] No patients with ICH score 0 died and all patients with ICH score 5-6 died hence proving the accuracy of ICH score in predicting mortality thus stratifying risk. This high rate of morbidity and mortality has necessitated more investigations for medical and surgical therapies in intracerebral hemorrhage.[19]With early surgery 63% of patients and with medical management 53% had a good outcome.[30] In this study 83% patients underwent surgical management have survived where as 81% patients who have undergone medical management for traumatic intracerebral bleed has survived. 85% patients managed conservatively for spontaneous intracerebral haemorrhage survived. This in turn could provide a vital role in

developing new treatment modalities for ICH, a disease with no proven beneficial treatment.[15]

7. Limitations of the study

Patients below the age of 18 years were excluded from the study. Functional outcome of the patients including recovery from disability could not be assessed after 6 months or 1 year period since only 30 day mortality was assessed in this study.

8. Conclusion

Using ICH score in our study we could assess the volume of bleed in the brain, along with neurological status of the patient (GCS) which guides the physician to determine whether medical or surgical management is needed. It is found in this study, rise in ICH score leads to increase in mortality hence proving the efficacy of ICH score in predicting the 30 day mortality due to ICH.

References

[1] An SJ, Kim TJ, Yoon BW. Epidemiology, Risk Factors, and Clinical Features of Intracerebral Hemorrhage: An Update. J Stroke. 2017 Jan;19(1):3-10. doi: 10.5853/jos.2016.00864. Epub 2017 Jan 31. PMID: 28178408; PMCID: PMC5307940.

[2] Feigin VL, Lawes CM, Bennett DA, Barker-Collo SL, Parag V. Worldwide stroke incidence and early case fatality reported in 56 population-based studies: a systematic review. Lancet Neurol. 2009 Apr;8(4):355-69. doi: 10.1016/S1474-4422(09)70025-0. Epub 2009 Feb 21. PMID: 19233729.

[3] Sacco S, Marini C, Toni D, Olivieri L, Carolei A. Incidence and 10-year survival of intracerebral hemorrhage in a population-based registry. Stroke. 2009 Feb;40(2):394-9. doi: 10.1161/STROKEAHA.108.523209. Epub 2008 Nov 26. PMID: 19038914.

[4] Unnithan AKA, M Das J, Mehta P. Hemorrhagic Stroke. 2022 Sep 30. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan–. PMID: 32644599.

[5] Qureshi AI, Qureshi MH. Acute hypertensive response in patients with intracerebral hemorrhage pathophysiology and treatment. J Cereb Blood Flow Metab. 2018 Sep;38(9):1551-1563. doi: 10.1177/0271678X17725431. Epub 2017 Aug 16. PMID: 28812942; PMCID: PMC6125978.

[6] Ruíz-Sandoval JL, Cantú C, Barinagarrementeria F. Intracerebral hemorrhage in young people: analysis of risk factors, location, causes, and prognosis. Stroke. 1999 Mar;30(3):537-41. doi: 10.1161/01.str.30.3.537. PMID: 10066848.

[7] Jabbarli R, Reinhard M, Roelz R, Shah M, Niesen WD, Kaier K, Taschner C, Weyerbrock A, Van Velthoven V. Intracerebral Hematoma Due to Aneurysm Rupture: Are There Risk Factors Beyond Aneurysm Location? Neurosurgery. 2016 Jun;78(6):813-20. doi: 10.1227/NEU.0000000000001136. PMID: 26619334.

[8] Lieu AS, Hwang SL, Howng SL, Chai CY. Brain tumors with hemorrhage. J Formos Med Assoc. 1999 May;98(5):365-7. PMID: 10420706.

[9] VanDerWerf J, Kumar MA. Diagnosis and Management of Coagulopathy-Related Intracerebral Hemorrhage. Semin Neurol. 2016 Jun;36(3):274-87. doi: 10.1055/s-0036-1582133. Epub 2016 May 23. PMID: 27214703.

[10] Pillai SH, Sreedharan SE, Menon G, Kannoth S, Pn S. Primary CNS vasculitis presenting as intraventricular bleeding. Ann Indian Acad Neurol. 2016 Jul-Sep;19(3):406-8. doi: 10.4103/0972-2327.186845. PMID: 27570401; PMCID: PMC4980972.

[11] Powers WJ. Intracerebral hemorrhage and head trauma: common effects and common mechanisms of injury. Stroke. 2010 Oct;41(10 Suppl):S107-10. doi: 10.1161/STROKEAHA.110.595058. PMID: 20876480; PMCID: PMC2953718.

[12] Miller EC, Elkind MS. Infection and Stroke: an Update on Recent Progress. CurrNeurolNeurosci Rep. 2016 Jan;16(1):2. doi: 10.1007/s11910-015-0602-9. PMID: 26677196; PMCID: PMC6440211.

[13] Zhang J, Yang Y, Sun H, Xing Y. Hemorrhagic transformation after cerebral infarction: current concepts and challenges. Ann Transl Med. 2014 Aug;2(8):81. doi: 10.3978/j.issn.2305-5839.2014.08.08. PMID: 25333056; PMCID: PMC4200641.

[14] Ropper AH, Samuels MA, Klein JP, Prasad S. eds. *Adams and Victor's Principles of Neurology, 11e*. McGraw Hill; 2019. Accessed August 07, 2023. https://neurology.mhmedical.com/content.aspx?bookid=1477&sectionid=85536145

[15] Hemphill JC 3rd, Bonovich DC, Besmertis L, Manley GT, Johnston SC. The ICH score: a simple, reliable grading scale for intracerebral hemorrhage. Stroke. 2001 Apr;32(4):891-7. doi: 10.1161/01.str.32.4.891. PMID: 11283388.

[16] *Henry H. Schmidek. Schmidek& Sweet Operative Neurosurgical Techniques : Indications, Methods, and Results. Philadelphia :W.B. Saunders, 2006.*

[17] https://neuropedia.net/intracerebral-hemorrhage-ich/articles/neurology/cerebrovascular/

[18] Tuhrim S, Horowitz DR, Sacher M, Godbold JH. Volume of ventricular blood is an important determinant of outcome in supratentorial intracerebral hemorrhage. Crit Care Med. 1999 Mar;27(3):617-21. doi: 10.1097/00003246-199903000-00045. PMID: 10199544.

[19] Sahni R, Weinberger J. Management of intracerebral hemorrhage. Vasc Health Risk Manag. 2007;3(5):701-9. PMID: 18078021; PMCID: PMC2291314.

[20] Warren AD, Li Q, Schwab K, McKaig B, Goldstein AN, Greenberg SM, Viswanathan A, Anderson C, Gurol ME, Patel A, Goldstein JN. External ventricular drain placement is associated with lower mortality after intracerebral hemorrhage with intraventricular hemorrhage. Int J Emerg Med. 2022 Sep 15;15(1):51. doi: 10.1186/s12245-022-00450-4. PMID: 36109697; PMCID: PMC9479417

[21] Dey M, Jaffe J, Stadnik A, Awad IA. External ventricular drainage for intraventricular hemorrhage. CurrNeurolNeurosci Rep 2012;12(1):24-33.

[22] Lovasik BP, McCracken DJ, McCracken CE, et al. The effect of external ventricular drain use in intracerebral hemorrhage. World Neurosurg2016;94:309-318.
[23] Reichart* and S. Frank et al,IntracerebralHemorrhage, Indication for Surgical Treatment and Surgical Techniques R. The Open Critical Care Medicine Journal, 2011, 4, 68-71
[24] Shi, Jing, Zou, Xiaohua, Jiang, Ke, Tan, Li, Wang, Likun, Ren, Siying, Mao, Yuanhong, Yang, Chunguang, Wang, Weijun, Wu, Guofeng and Tang, Zhouping. "Intracerebral hemorrhage with tentorial herniation: Conventional open surgery or emergency stereotactic craniopuncture aspiration surgery?" *Translational Neuroscience*, vol. 12, no. 1, 2021, pp. 198-209. https://doi.org/10.1515/tnsci-2020-0173
[25] Teasdale G, Jennett B. Assessment of coma and impaired consciousness: a practical scale. **Lancet**.1974; *2*:81–84.
[26] Hunt WE, Hess RM. Surgical risk as related to time of intervention in the repair of intracranial aneurysms. **J Neurosurg**.1968; *28*:14–20.
[27] Report of World Federation of Neurological Surgeons Committee on a Universal Subarachnoid Hemorrhage Grading Scale. **J Neurosurg**.1988; *68*:985–986.
[28] Brott T, Adams HP Jr, Olinger CP, Marler JR, Barsan WG, Biller J, Spilker J, Holleran R, Eberle R, Hertzberg V, et al. Measurements of acute cerebral infarction: a clinical examination scale. **Stroke**.1989; *20*:864–870.
[29] Spetzler RF, Martin NA. A proposed grading system for arteriovenous malformations. **J Neurosurg**.1986; *65*:476–483
[30] Gregson BA, Rowan EN, Francis R, McNamee P, Boyers D, Mitchell P, McColl E, Chambers IR, Unterberg A, Mendelow AD; STITCH(TRAUMA) investigators. Surgical Trial In Traumatic intraCerebral Haemorrhage (STITCH): a randomised controlled trial of Early Surgery compared with Initial Conservative Treatment. Health Technol Assess. 2015 Sep;19(70):1-138. doi: 10.3310/hta19700. PMID: 26346805; PMCID: PMC4780887.