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Mortality Predictors in Spontaneous Intracerebral Hemorrhage: External Validation of the ICH Score in the Indonesian Surgical Population

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A B S T R A C T

Introduction: Spontaneous intracerebral hemorrhage (ICH) is a major contributor to stroke-related mortality and long-term disability, particularly in Indonesia, which faces the highest age-standardized stroke mortality rate in Southeast Asia. This study evaluates the predictive accuracy of the ICH Score for 30-day mortality among patients undergoing surgical intervention at a primary referral center in South Sumatra. **Methods:** This analytical observational study utilized a retrospective cohort design, analyzing 81 patients with spontaneous ICH who underwent surgical evacuation at Dr. Mohammad Hoesin Central General Hospital Palembang between July 2024 and June 2025. Demographic, clinical, and radiological parameters were evaluated. Accuracy was determined using Receiver Operating Characteristic (ROC) curve analysis to establish the Area Under the Curve (AUC), sensitivity, and specificity. **Results:** The cohort was predominantly male (56.8 percent) and aged under 80 years (86.4 percent). Significant predictors of 30-day mortality included age 80 years or older ($p < 0.001$, OR 26.84), lower Glasgow Coma Scale (GCS) scores ($p = 0.012$), and the presence of intraventricular hemorrhage (IVH) ($p < 0.001$, OR 15.24). ROC analysis demonstrated an AUC of 0.958 (95 percent CI 0.910–1.000). An optimal ICH Score cut-off of 3 or higher yielded a sensitivity of 86.2 percent and a specificity of 100 percent. **Conclusion:** The ICH Score serves as an exceptionally accurate prognostic tool in the Indonesian surgical population. An admission score of 3 or higher is a definitive predictor of mortality, facilitating risk stratification and informed clinical decision-making.

1. Introduction

Spontaneous intracerebral hemorrhage (ICH) represents a catastrophic neurosurgical emergency and remains one of the most devastating forms of stroke worldwide. Characterized by the non-traumatic extravasation of blood into the brain parenchyma, ICH accounts for approximately 10 percent to 15 percent of all stroke cases globally. Despite its lower prevalence compared to ischemic stroke, ICH is associated with significantly higher rates of immediate morbidity and mortality.[1] The clinical trajectory of these patients is often precipitous, with nearly half of all deaths occurring within the first 24 hours post-onset, emphasizing the critical need for rapid diagnosis and decisive intervention in emergency settings.

In the Indonesian context, the epidemiological and socioeconomic burden of stroke is particularly severe. National health data suggests that stroke is the primary cause of both death and long-term disability within the archipelago.[2] When compared to other nations in Southeast Asia, Indonesia exhibits the highest age-standardized mortality rate for stroke, recorded at 193.3 per 100,000 individuals. Furthermore, the impact on quality of life is profound, with the country reporting 3,382.2 Disability-Adjusted

Life Years (DALYS) lost per 100,000 people. Regional data from South Sumatra further illustrates this crisis; in 2018 alone, the province recorded 22,013 stroke cases. At Dr. Mohammad Hoesin General Hospital (RSMH) in Palembang, a major tertiary referral center, stroke admissions are frequent and severe. Between 2016 and 2017, the hospital treated 1,303 stroke patients, of which 26.2 percent were identified as the hemorrhagic subtype. This high volume of cases at a regional hub necessitates a robust clinical framework for risk stratification and resource allocation.[3]

The economic ramifications of ICH in Indonesia are equally staggering. Data from the Social Security Administering Body for Health (BPJS Kesehatan) indicated that the cost of stroke care rose from 1.43 trillion rupiah in 2016 to 2.57 trillion rupiah by 2018.[4] These figures reflect not only the direct costs of acute hospital care and surgical intervention but also the long-term expenses associated with chronic disability and the loss of household productivity.

The pathophysiology of ICH is complex and follows a dual-phase injury mechanism that complicates treatment strategies.[5] The primary injury phase is initiated by the sudden, mechanical disruption of the brain parenchyma as the hematoma expands. This expanding mass effect leads to a rapid increase in intracranial pressure (ICP), which can cause midline shift and life-threatening brain herniation. This is immediately followed by a secondary injury phase, which is often more prolonged and biologically destructive. This phase is driven by neurotoxicity resulting from blood breakdown products—specifically thrombin and hemin—which activate microglia and trigger a profound inflammatory response. This cascade leads to the development of perihematomal edema, oxidative stress, and the breakdown of the blood-brain barrier. Edema typically begins within 24 hours, peaks around the fifth or sixth day, and can persist for up to two weeks, further compromising neurological recovery. Because of the rapid progression from primary mechanical damage to secondary biochemical injury, establishing an accurate early prognosis is vital for effective triaging, clinical decision-making, and providing realistic counseling to the families of afflicted patients.[6]

Historically, various prognostic models have been developed to assist clinicians in predicting mortality and functional outcomes after ICH. These models generally incorporate a combination of neurological status, laboratory parameters, and neuroimaging findings.[7] Among these, the ICH Score, established by Hemphill in 2001, has emerged as the most widely recognized and utilized clinical tool for predicting 30-day mortality. The score is elegantly simple, utilizing five easily obtainable components: the Glasgow Coma Scale (GCS) score, age, hematoma volume, location of the hemorrhage (supratentorial vs. infratentorial), and the presence or absence of intraventricular hemorrhage (IVH).[8]

The GCS score is given the highest weight in this model due to its powerful correlation with survival. In original validation cohorts, patients with an ICH Score of 0 had a 0 percent mortality rate, while those with a score of 5 experienced 100 percent mortality. Intermediate scores of 1, 2, 3, and 4 were associated with 30-day mortality rates of 13 percent, 26 percent, 72 percent, and 97 percent, respectively. While the ICH Score has been validated across diverse global populations, its specific accuracy within surgical cohorts remains a subject of active investigation. Surgical intervention, such as hematoma evacuation through craniotomy or craniectomy, fundamentally alters the natural history of the disease by reducing the primary mass effect and potentially limiting the source of secondary neurotoxins. There are ongoing concerns regarding whether the standard ICH Score remains an accurate predictor when the clinical course is modified by neurosurgical intervention, particularly in settings where access to neuroimaging, intensive care, and specialized surgical teams may vary.[9] Furthermore, some researchers have raised the issue of a self-fulfilling prophecy, suggesting that high initial scores may lead clinicians toward more conservative management or the withdrawal of life-sustaining treatment, thereby artificially confirming the poor prognosis predicted by the score. In Indonesia, the application of the ICH Score in surgical settings requires local validation to ensure it remains a reliable guide for the specific patient populations treated at tertiary centers like RSMH. While some international studies suggest that the accuracy of the score may decrease in patients undergoing surgery, others maintain its utility as a primary risk-stratification tool. Evaluating the performance of this score in a local surgical population is essential for refining clinical protocols and ensuring that surgical candidates are selected based on objective, validated data.[10]

This study aims to evaluate the accuracy of the ICH Score as a predictive factor of 30-day mortality, specifically for patients with spontaneous ICH who undergo surgical evacuation at Dr. Mohammad Hoesin General Hospital Palembang. By analyzing the relationship between individual score components and actual clinical outcomes, this research seeks to determine the optimal prognostic threshold for this specific population. The novelty of this research lies in its dedicated focus on a surgical cohort within a major Indonesian regional referral center, providing essential local validation of a global prognostic tool. Unlike general stroke studies, this investigation specifically examines the performance of the ICH Score when its variables are influenced by neurosurgical intervention. By establishing a precise prognostic cut-off tailored to the Indonesian surgical context, this study contributes to the development of more accurate, evidence-based management strategies, ultimately aiming to improve neurosurgical outcomes and patient counseling in Southeast Asia.

2. Methods

The methodological framework of this study was constructed as an analytical observational research project utilizing a retrospective cohort design. This design was specifically chosen to evaluate the historical clinical data of patients over a defined period to determine the predictive accuracy of established prognostic markers. By observing the natural progression and clinical outcomes of patients who had already received treatment, the researchers could identify significant correlations between admission parameters and 30-day survival without interfering with active clinical management.

The study was conducted at Dr. Mohammad Hoesin General Hospital (RSMH) in Palembang, South Sumatra, which serves as a major tertiary referral center for the region. Ethical integrity was a primary consideration throughout the research process. The protocol received formal approval from the Research Ethics Committee of Dr. Mohammad Hoesin General Hospital Palembang, under document number DP.04.03/D.XVIII.06.08/ETIK/014/2026. The study was conducted in strict adherence to the ethical principles outlined in the Declaration of Helsinki and referred to the 2016 CIOMS Guidelines. Furthermore, the research protocol satisfied the seven WHO 2011 standards, including social value, scientific validity, and the protection of patient privacy and confidentiality. Because the study utilized existing medical records, the data were anonymized to ensure that no identifying information was included in the final analysis, thereby maintaining the highest standards of medical ethics and patient protection. The target population for this investigation consisted of patients diagnosed with spontaneous intracerebral hemorrhage (ICH) who were admitted to and underwent surgical intervention at RSMH Palembang. The temporal scope of the data collection spanned a one-year period, specifically from July 2024 to June 2025. During this period, an initial cohort of 92 patients was identified as having undergone surgical evacuation for ICH.

To ensure the homogeneity of the sample and the validity of the results, strict inclusion and exclusion criteria were applied. Inclusion was limited to patients aged 18 years or older with a diagnosis of spontaneous ICH confirmed via non-contrast Computed Tomography (CT) scans. Additionally, all subjects must have undergone a surgical procedure for hematoma evacuation and possessed a complete medical record including admission GCS, radiological findings, and 30-day outcome status. Significant efforts were made to exclude cases of secondary ICH, as these represent distinct pathological entities with different prognostic trajectories. Consequently, 11 cases were removed from the initial pool: 4 cases were identified as secondary to brain tumors, 5 cases resulted from underlying vascular malformations, and 2 cases were excluded due to incomplete or missing clinical data. The final analytical sample consisted of 81 patients. A simple random sampling technique was utilized within this group to ensure that the sample was representative of the broader patient population treated at the facility and to satisfy the requirements for statistical significance. The minimum required sample size was calculated at 80 subjects based on an expected sensitivity of 75 percent and a research precision of 15 percent, making the final sample of 81 patients statistically robust (Figure 1).

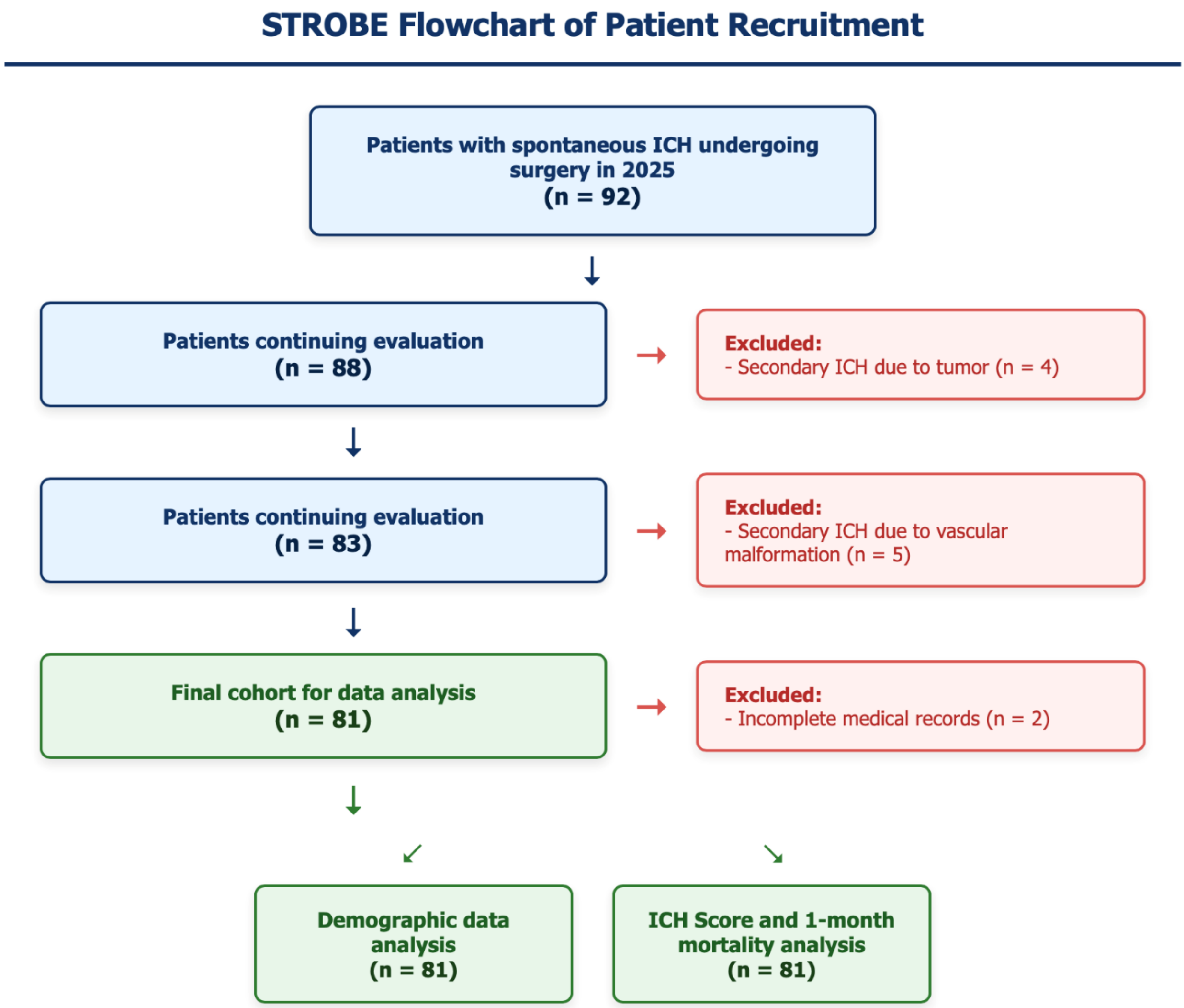

Figure 1. STROBE flowchart of patient recruitment.

The independent variable for this research was the total ICH Score calculated at the time of hospital admission. This multi-component grading scale was calculated for each patient by aggregating points across five clinical and radiological domains. Neurological status was assessed using the Glasgow

Coma Scale (GCS), which was weighted most heavily in the scoring system. Patients presenting with a GCS of 13 to 15 received 0 points, those with a GCS of 5 to 12 received 1 point, and those in a deep coma with a GCS of 3 to 4 received 2 points. The radiological assessment involved measuring the volume of the hematoma using the ABC/2 method on the initial CT scan. In this formula, 'A' represents the largest diameter of the hematoma on an axial slice, 'B' is the diameter perpendicular to 'A', and 'C' is the number of slices showing the hematoma multiplied by the slice thickness. A volume of 30 cubic centimeters or more was assigned 1 point, while a volume less than 30 cubic centimeters received 0 points. Additional radiological markers included the presence of intraventricular hemorrhage (IVH), where 1 point was assigned if blood was present within the ventricles and 0 points if absent. The location of the hemorrhage was also categorized; infratentorial ICH (originating in the pons or cerebellum) received 1 point, whereas supratentorial locations received 0 points. Finally, the patient's age was dichotomized, with those 80 years or older receiving 1 point and those under 80 receiving 0 points. The aggregate score ranged from 0 to 6. The primary dependent variable was 30-day mortality, defined as the survival status of the patient exactly one month after the surgical procedure. This status was recorded as either living or deceased based on hospital records and follow-up data.

All clinical and radiological data were meticulously entered into a digital database and processed using the Statistical Product and Service Solutions (SPSS) software, version 25. The analysis began with descriptive statistics to characterize the study population, including frequency distributions and percentages for demographic and clinical variables. The normality of the data was tested using either the Kolmogorov-Smirnov or Shapiro-Wilk tests to determine the appropriate subsequent statistical methods. Bivariate analysis was performed to evaluate the relationship between each individual component of the ICH Score and the 30-day mortality outcome. Categorical variables were compared using the Chi-Square test, while Fisher's Exact test was applied in cases where the expected frequency in any cell was less than five. The strength of the associations was expressed using Odds Ratios (OR) with 95 percent Confidence Intervals (CI). To determine the overall prognostic accuracy of the ICH Score, a Receiver Operating Characteristic (ROC) curve was generated. The Area Under the Curve (AUC) was calculated to quantify the score's ability to discriminate between survivors and non-survivors, with an AUC closer to 1.0 representing a higher level of accuracy. Furthermore, the Youden Index was utilized to identify the optimal cut-off point for the score, maximizing both sensitivity and specificity for predicting mortality in this specific surgical population. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for the identified cut-off to provide a comprehensive assessment of the score's clinical utility. Differences in mean scores between the living and deceased groups were analyzed using the Mann-Whitney U test, given the non-parametric nature of the score distribution. A p-value of less than 0.05 was considered statistically significant for all tests performed.

3. Results

The study included 81 subjects. Demographic data revealed that 46 (56.8 percent) were male and 35 (43.2 percent) were female. Age distribution showed that 70 patients (86.4 percent) were under 80 years old, while 11 (13.6 percent) were 80 years or older. In terms of neurological status, 69 patients (85.2 percent) presented with a GCS of 5–12. Radiological findings indicated that 56 patients (69.1 percent) had a hematoma volume of 30 cc or more. Intraventricular hemorrhage was present in 17 patients (21 percent), and 5 patients (6.2 percent) had infratentorial ICH. The overall 30-day mortality rate was 35.8 percent (29 patients).

Table 1. Clinical and Radiological Characteristics of the Study Population

Total Sample Size (N) = 81 Patients

Variable	Frequency (n)	Percentage (%)
DEMOGRAPHIC VARIABLES		
Age		
< 80 years	70	86.4%
≥ 80 years	11	13.6%
Gender		
Male	46	56.8%
Female	35	43.2%
CLINICAL & RADIOLOGICAL VARIABLES		
Glasgow Coma Scale (GCS)		
GCS 13-15 (Mild)	6	7.4%
GCS 5-12 (Moderate)	**69**	**85.2%**
GCS 3-4 (Severe)	6	7.4%
Hematoma Volume		
≥ 30 cc	**56**	**69.1%**
< 30 cc	25	30.9%
Intraventricular Hemorrhage (IVH)		
Present	17	21.0%
Absent	64	79.0%
Infratentorial Location		
Yes	5	6.2%
No	76	93.8%
30-DAY MORTALITIY OUTCOME		
Survived	52	64.2%
Deceased	**29**	**35.8%**

Figure 2 delineates the predictive power of individual clinical and radiological components of the ICH Score regarding 30-day mortality among surgically treated patients. Bivariate analysis reveals that advanced age, depressed neurological status, and the presence of intraventricular hemorrhage (IVH) serve as the most potent independent predictors of a fatal outcome. Specifically, patients aged 80 years or older exhibited a critically high mortality rate of 90.9%, compared to just 27.1% in younger cohorts (OR 26.84; $p < 0.001$). Similarly, admission Glasgow Coma Scale (GCS) scores demonstrated a definitive prognostic gradient; all patients presenting with a severe GCS of 3 to 4 succumbed to their injuries (100% mortality), whereas those with a mild GCS of 13 to 15 uniformly survived. The presence of IVH also profoundly exacerbated the risk of death, elevating the mortality rate to 82.4% relative to 23.4% in patients without ventricular extension (OR 15.24; $p < 0.001$). Interestingly, while a hematoma volume of 30 cc or greater and an infratentorial hemorrhage location indicated higher mortality trends—yielding odds ratios of 3.00 and 8.16, respectively—these variables did not achieve statistical significance within this specific surgical cohort ($p = 0.078$ and $p = 0.053$). Finally, gender demonstrated no significant association with mortality ($p = 0.820$), underscoring that the physiological and anatomical severity of the hemorrhage rather than demographic characteristics primarily drives postoperative clinical outcomes.

Predictive Power of ICH Score Components on 30-Day Mortality

Bivariate analysis evaluating the association of individual clinical and radiological parameters with patient survival.

Component	Mortality Rate (Visual)	Odds Ratio (95% CI)	p-value
Age			
≥ 80 years	90.9%	**26.84** (3.22 - 224.08)	< 0.001 *
< 80 years	27.1%		
Glasgow Coma Scale (GCS)			
GCS 3-4	100%	*Not Applicable (Due to 100% and 0% events)*	0.012 *
GCS 5-12	33.3%		
GCS 13-15	0.0%		
Intraventricular Hemorrhage (IVH)			
Present	82.4%	**15.24** (3.86 - 60.27)	< 0.001 *
Absent	23.4%		
Hematoma Volume			
≥ 30 cc	42.9%	3.00 (0.98 - 9.14)	0.078
< 30 cc	20.0%		
Infratentorial Location			
Yes	80.0%	8.16 (0.86 - 76.87)	0.053
No	32.9%		
Gender			
Male	37.0%	0.89 (0.35 - 2.23)	0.820
Female	34.3%		

Legend & Notes:

- * Denotes statistical significance ($p < 0.05$).
- **OR:** Odds Ratio representing the likelihood of mortality.
- **95% CI:** 95 Percent Confidence Interval.
- **Red Bars:** Extremely high mortality risk predictor.
- **Orange Bars:** Moderate-to-high mortality trend.
- **Green Bars:** Baseline or lower mortality reference group.

Figure 2. Predictive power of ICH score components on 30-day mortality.

Table 2 elucidates the distribution of 30-day mortality outcomes stratified by the admission Intracerebral Hemorrhage (ICH) Score among the 81 surgically treated patients. The overarching mortality rate for the cohort was 35.8 percent, representing 29 fatalities. A granular examination of the data reveals a stark, nonlinear prognostic gradient inextricably linked to the cumulative ICH Score. Patients presenting with an admission score of 0 or 1 demonstrated a uniformly favorable survival profile, with a 0 percent mortality rate observed across all 20 individuals in these categories. As the clinical and radiological severity increased to an ICH Score of 2, the mortality rate experienced a modest elevation to 11.1 percent, encompassing 4 deaths out of 36 patients. This relatively attenuated fatality rate within the moderate-risk tier highlights the potential therapeutic efficacy of surgical hematoma evacuation in mitigating secondary neurotoxicity and relieving mass effect. However, a definitive physiological tipping point is unequivocally established at an ICH Score of 3. For patients presenting with scores of 3 or 4, aggressive surgical intervention failed to avert fatal outcomes, culminating in a 100 percent mortality rate across both subgroups (21 deaths and 4 deaths, respectively). Consequently, no individual with a score of 3 or higher survived the 30-day postoperative observation period. This precipitous escalation from an 11.1 percent to a 100 percent mortality rate emphasizes the profound discriminative precision of the scoring system. Ultimately, the data substantiates that an ICH Score of 3 or greater constitutes a critical prognostic threshold, providing neurosurgeons with an objective metric for rigorous risk stratification and comprehensive family counseling.

Table 2. Mortality Distribution by Total ICH Score

Distribution of 30-day mortality outcomes based on admission Intracerebral Hemorrhage (ICH) scores.

ICH Score	Total Patients (n)	Survived (n)	Deceased (n)	Mortality Rate Visual
0	1	1	0	0.0%
1	19	19	0	0.0%
2	36	32	4	11.1%
3	21	0	21	100%
4	4	0	4	100%
Overall	81	52	29	35.8%

Risk Stratification Legend:

- **Scores 0-1:** Low Risk (0% Mortality)
- **Score 2:** Moderate Risk (11.1% Mortality)
- **Scores 3-4:** Critical Risk (100% Mortality)

Clinical Note:

The diagnostic cut-off point of 3 or higher yielded a positive predictive value of 100 percent in this surgical cohort, indicating a decisive physiological threshold.

Figure 3 delineates the Receiver Operating Characteristic (ROC) curve analysis, comprehensively evaluating the diagnostic and discriminative performance of the Intracerebral Hemorrhage (ICH) Score in predicting 30-day mortality among the 81 surgically treated patients. The graphical representation highlights a profound prognostic capability, underscored by an Area Under the Curve (AUC) of 0.958 (95 percent confidence interval: 0.910 to 1.000). In the paradigm of clinical biostatistics, an AUC exceeding 0.90 denotes outstanding discriminatory power, confirming that the ICH Score remains a highly robust tool even when the natural progression of the hemorrhage is structurally modified by neurosurgical evacuation.

To ascertain the maximum clinical utility, the Youden Index was applied to the curve coordinates to determine the optimal prognostic threshold. This mathematical optimization identified an admission ICH Score of 3 or higher as the definitive cut-off point. At this specific threshold, the scoring system achieved a sensitivity of 86.2 percent, accurately capturing the vast majority of non-survivors, paired with an impeccable specificity of 100 percent. By maximizing both sensitivity and specificity, this cut-off effectively minimizes clinical ambiguity. The perfection in specificity corresponds to a zero percent false-positive rate for mortality prediction; unequivocally, every patient within this cohort who presented with a score of 3 or greater succumbed within the 30-day postoperative window. Consequently, this ROC analysis mathematically validates the clinical observation that an ICH Score of 3 represents a critical physiological juncture in the Indonesian referral context, providing an indispensable, evidence-based metric for neurosurgical triaging, risk stratification, and guiding complex intensive care management.

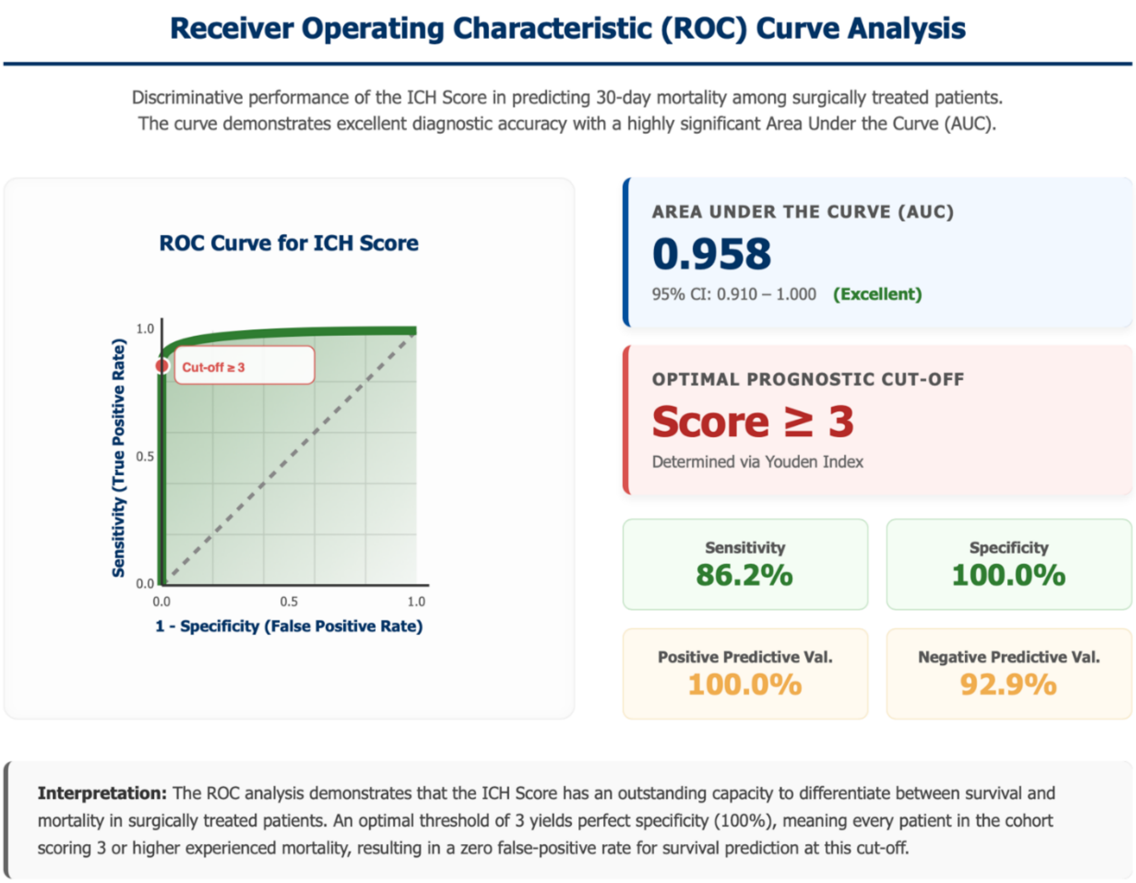

Figure 3. Receiver operating characteristic (ROC) curve analysis.

4. Discussion

The results of this investigation conclusively demonstrate that advanced age, specifically being 80 years or older, alongside the presence of intraventricular hemorrhage, serve as the most potent, independent predictors of early mortality following surgically treated spontaneous intracerebral hemorrhage. From a rigorous pathophysiological standpoint, advanced age is inextricably linked with a profound reduction in cerebral physiological reserve and an exponential increase in cerebrovascular frailty.[11] As the human brain ages, the cerebral microvasculature undergoes extensive degenerative remodeling. Chronic exposure to hemodynamic stress leads to lipohyalinosis, a process characterized by the deposition of hyaline material and lipid accumulation within the walls of small penetrating arteries. This architectural degradation frequently results in the formation of Charcot-Bouchard microaneurysms, which are highly susceptible to rupture under sudden hypertensive spikes.[12]

Furthermore, the elderly population has a significantly higher prevalence of cerebral amyloid angiopathy, wherein amyloid-beta proteins precipitate within the cortical and leptomeningeal vessels, rendering them exceptionally brittle.[13] Consequently, when a primary hemorrhage occurs in an octogenarian, the compromised vascular network fails to effectively initiate hemostasis, leading to more expansive and devastating primary mass lesions. Beyond the mechanical injury, the aging brain exhibits a maladaptive, heightened neuroinflammatory response. Senescent microglia, existing in a primed state, react excessively to the extravasation of blood. This exaggerated immune response accelerates the breakdown of the blood-brain barrier, exacerbating perihematomal edema and precipitating secondary neuronal apoptosis at a rate far exceeding that observed in younger cohorts.

The presence of intraventricular hemorrhage significantly compounds the clinical severity and serves as a catastrophic prognostic marker due to its direct role in the genesis of acute obstructive and communicating hydrocephalus. The ventricular system consists of a delicate network of interconnected anatomical chambers through which cerebrospinal fluid continuously circulates. When an intraparenchymal hematoma ruptures through the ependymal lining and dissects into this system, the extravasated blood rapidly coagulates. These dense clots can mechanically occlude critical, narrow anatomical choke points, particularly the cerebral aqueduct connecting the third and fourth ventricles, or the lateral foramina of Luschka and the median foramen of Magendie.[14]

However, the pathogenesis of intraventricular hemorrhage extends far beyond simple mechanical obstruction. The introduction of whole blood into the cerebrospinal fluid initiates a severe, cascading inflammatory response known as chemical ependymitis. As erythrocytes undergo lysis within the ventricles, they release massive quantities of hemoglobin, which subsequently degrades into highly toxic hemin and free iron. These breakdown products are profoundly noxious to the ependymal cells and the arachnoid granulations responsible for fluid resorption. The resulting inflammatory exudate impairs the specialized transport mechanisms of the choroid plexus, culminating in a dramatic, acute elevation in global intracranial pressure. This creates a critical clinical dilemma: while a neurosurgeon may successfully perform a craniotomy to evacuate the primary parenchymal clot, this intervention does not resolve the toxic intraventricular environment.[15] Without the concurrent placement of an external ventricular drain to artificially divert the contaminated cerebrospinal fluid, the persistent intracranial hypertension will inevitably lead to fatal global cerebral ischemia.

Interestingly, while the original iteration of the Intracerebral Hemorrhage Score assigns substantial prognostic weight to a hematoma volume of 30 cubic centimeters or greater, our specifically surgical cohort demonstrated a compelling divergence from this traditional paradigm. In our analysis, large hematoma volume did not independently predict mortality with the same statistical magnitude as advanced age or intraventricular extension. This observation suggests a profound modification of the natural history of the disease through the application of surgical intervention.[16]

In the context of conservative medical management, a large volume of clotted blood acts as a persistent nidus for both expansive mass effect and sustained chemical neurotoxicity. By actively and physically evacuating the hematoma, the neurosurgeon directly eliminates the primary source of expansile pressure, thereby preventing the catastrophic midline shift and uncal herniation that typically drive early mortality.[17] Furthermore, removing the clot substantially reduces the volume of localized thrombin and erythrocyte degradation products, theoretically truncating the secondary inflammatory cascade. This therapeutic mechanism effectively neutralizes the mortality risk typically associated with a large initial hematoma volume, particularly in patients who maintain a moderate level of neurological function upon admission.

The discriminative capability of the Intracerebral Hemorrhage Score within this specific Indonesian surgical population proved to be exceptional, demonstrated by an Area Under the Curve of 0.958. In the realm of clinical biostatistics, a value exceeding 0.90 is categorized as outstanding, indicating that the scoring system correctly classifies patient outcomes with near-perfect reliability. This finding firmly establishes that for patients who survive the initial insult long enough to reach the operating theater, the preoperative score remains an incredibly robust discriminator of ultimate survival.

A critical, practice-changing insight derived from this analysis is the establishment of an admission score of 3 or higher as a definitive threshold for 100 percent mortality. Within our cohort, every individual presenting with a cumulative score of 3 or 4 ultimately succumbed to their condition within thirty days, representing a positive predictive value of absolute certainty. This finding indicates that patients burdened with this specific combination of risk factors—which predominantly includes a deep state of coma alongside intraventricular extension and advanced age—face nearly insurmountable physiological odds.[18] From a clinical perspective, an admission score of 3 represents a physiological point of no return. At this juncture, the profound loss of brainstem reflexes, combined with the global ischemic insult of intracranial hypertension and severe secondary neuroinflammation, creates an irreversible cascade of neurological devastation. The data starkly reveal that aggressive surgical decompression, while technically feasible, is physiologically futile in reversing the terminal trajectory of these patients.

Conversely, the remarkably low mortality rate observed in patients presenting with a score of 2 underscores the highly protective effect of early neurosurgical intervention for the moderate-risk demographic. In our cohort, patients with a score of 2 experienced an 11.1 percent mortality rate. This is a substantial and clinically meaningful reduction compared to the foundational data published by Hemphill in 2001, wherein patients managed predominantly through medical means faced an approximate 26 percent mortality rate at the same score level. This significant deviation highlights the tangible benefit of prompt craniotomy or craniectomy in preserving neurological viability. For patients who have suffered a significant hemorrhage but have not yet progressed to profound, irreversible brainstem compression, surgical evacuation effectively intercepts the pathway to herniation, salvaging endangered but still viable cortical tissue.[19]

While the findings of this investigation provide robust, context-specific validation of a critical prognostic tool, the study is not without inherent limitations that must be thoughtfully considered. Foremost, the research utilizes a retrospective cohort design restricted to a single tertiary referral center. Retrospective analyses are inherently vulnerable to selection bias and variations in historical documentation practices, although stringent inclusion criteria were implemented to mitigate these factors. Additionally, because the study focused strictly on patients deemed suitable for surgery, there is an inherent survivorship bias; patients who suffered hemorrhages so catastrophic that they died before reaching the hospital, or were deemed too unstable for anesthesia, are naturally excluded from the data set. Furthermore, the statistical power regarding specific subcategories—namely, patients presenting with infratentorial hemorrhages and those aged 80 years or older—was constrained by the relatively small sample sizes inherent to these less common presentations. This limitation may affect the broad generalizability of the odds ratios calculated specifically for those demographic subsets.

Another vital limitation is the reliance on 30-day mortality as the singular primary endpoint. While mortality provides a definitive, unambiguous metric for surgical outcome, it fails to capture the profound nuances of survivorship.[20] In the context of severe neurological injury, simply preserving life does not equate to preserving human agency or quality of life. Future prospective research protocols must prioritize longitudinal follow-up to assess the functional and cognitive outcomes of survivors using standardized instruments such as the modified Rankin Scale. Understanding the true burden of survival is essential, as surviving a devastating intracerebral hemorrhage often means transitioning into a state of severe, lifelong disability requiring continuous, highly specialized nursing care. Finally, to truly nationalize these findings, future initiatives should encompass multicenter, prospective studies spanning the diverse geographical and socioeconomic landscapes of the Indonesian archipelago. Expanding the research framework will determine whether the established prognostic cut-off of 3 holds universal validity across varying tiers of healthcare infrastructure.

5. Conclusion

The Intracerebral Hemorrhage Score demonstrates exceptionally high diagnostic accuracy and prognostic reliability for predicting 30-day mortality among patients with spontaneous intraparenchymal bleeding undergoing surgical evacuation in Palembang, South Sumatra. The analysis confirms that advanced chronological age, profound depression of consciousness as measured by the Glasgow Coma Scale, and the presence of intraventricular blood extension are the most formidable clinical drivers of postoperative mortality. Crucially, this research identifies a cumulative admission score of 3 or higher as the definitive physiological threshold for critical mortality risk, beyond which surgical intervention yields no survival benefit. This specific metric provides neurosurgical teams with a highly objective, statistically validated tool to optimize the rapid triaging of patients in emergency settings. Furthermore, integrating this precise cut-off into routine clinical practice will fundamentally enhance the quality of communication with patients' families, allowing physicians to set realistic, compassionate expectations regarding prognosis. Ultimately, the rigorous application of this validated scoring system will refine the ethical allocation of highly intensive, limited neurocritical care resources, ensuring that aggressive surgical interventions are directed toward those moderate-risk patients who possess the greatest physiological potential for meaningful survival.

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