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# Are hematoma size and treatment timing associated with outcome in aneurysmal intracerebral hemorrhage? A systematic review of published case reports and case series

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## Abstract

# Objective

This systematic review examines the associations of hematoma characteristics, clinical status, and treatment timing with outcomes in patients with aneurysmal intracerebral hemorrhage (ICH).

# Methods

A literature search of the MEDLINE database, conducted according to PRISMA guidelines, identified approximately 10,000 records. After screening and full-text assessment, 93 studies were included, comprising 136 patients from case reports and 2,388 patients from case series.

# Results

Good neurological status was more common in patients with small hematomas (SICH) than in those with large hematomas (LICH) (61.5% vs. 20.4%) and in the case-series cohort (42.1%). LICH was primarily treated with microsurgical procedures (MS) (78.5% in case reports and **74.7%** in case series, $p < 0.0001$). In SICH, treatment was more evenly distributed between MS and endovascular treatment (EVT) (53.8% vs. 36.5%, $p = 0.063$). SICH patients had more favorable outcomes, whereas early treatment was not associated with better outcomes in the case-report cohort ($p = 0.481$ and $p = 0.81$ for the respective comparisons). In the case-series cohort, treatment at > 24–72 hours (D) was associated with more favorable observed outcomes than treatment within 24 hours (E) ($p < 0.001$). Early treatment was also associated with more favorable outcomes than treatment > 72 hours or with unreported timing (Un) ($p < 0.001$); however, this association was not statistically significant when the D and Un groups were combined (E vs. D + Un, $p = 0.167$). Notably, a substantial proportion of patients with good initial clinical status had unfavorable outcomes ($p < 0.001$).

# Conclusion

Small and large hematomas were associated with different clinical presentations and outcomes. In the case-report cohort, treatment timing was not independently associated with outcome after adjustment for clinical status. In the case-series cohort, the D group had more favorable observed outcomes than the E group; however, this finding is susceptible to baseline differences, treatment-selection bias, and other confounding factors and should not be interpreted as evidence that delayed treatment is superior to early treatment

## Introduction

The reported frequency of aneurysm rupture into the brain parenchyma ranges from 4% to 45.6% [1–3]. Several factors have been proposed to explain this phenomenon, including the aneurysm's proximity to brain tissue, the limited width of the subarachnoid space, orientation of the aneurysm dome toward the cortex, adherence to the pia mater, and rapid filling of the subarachnoid space with blood, fibrin, or dense arachnoid material following rupture [4–9]. Intracerebral hemorrhage can cause increased intracranial pressure and brain displacement, contributing to early brain injury and potentially influencing clinical outcome [10,11].

Clinical outcomes are influenced by multiple factors. However, reported results are heterogeneous and, at times, contradictory, and no definitive consensus exists regarding the optimal management of these patients.

To address these uncertainties, we conducted a systematic review of aneurysmal intracerebral hemorrhage (aICH). We focused on hematoma size, clinical status, and treatment timing as factors that may be associated with functional outcome in patients with aICH. We included published case reports and case series of patients with aICH and stratified the data according to hematoma size, clinical status, and treatment timing.

## Materials and Methods

Search Strategy and Study Selection

This study was conducted as a systematic review with pooled analysis of published case reports and case series according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive literature search was conducted using the Medline database with the following keywords: "intracerebral hemorrhage," "saccular intracranial aneurysms," "aneurysmal intracranial hemorrhage," "intracerebral hematoma," "aneurysmal rupture," "clipping aneurysms," and "endovascular treatment of aneurysms."

The last search of the Medline database (via PubMed) took place on February 28, 2025, with filters applied for humans, the English language, and studies published from 2000 onward. Google Scholar was additionally screened as a supplementary source to identify potentially eligible publications, with the last search also conducted on February 28, 2025. To create a more homogeneous patient group, we excluded publications related to other types of aneurysms (such as dissecting, pseudo-aneurysms, blister, and atherosclerotic aneurysms), abstracts published before 2000, other forms of cerebral hemorrhage, and reports of remote, delayed, or distant parenchymal hematomas associated with aneurysms. The initial systematic search across databases yielded approximately 10,000 records. All records were screened according to predefined inclusion and exclusion criteria, and studies meeting the eligibility criteria were included in the final analysis. Case reports and case series were assessed for methodological quality using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Reports and the JBI Critical Appraisal Checklist for Case Series. After removal of duplicates and screening of titles and abstracts, 768 records remained for full-text assessment. Of these, 96 reports

initially met the inclusion criteria; three were subsequently excluded because of insufficient information on clinical status or treatment timing, leaving 93 studies for the final analysis. Specifically, these studies did not provide clear information on the number of early or delayed treatments. Treatment timing was often incompletely or imprecisely reported .The final dataset comprised 68 case reports and 25 case series, which were included in the methodological quality assessment presented in Tables 1–3. Because the objective was to characterize the available published evidence rather than to estimate an intervention effect from comparative studies, no study was excluded solely on the basis of its appraisal score.

The appraisal results were used to characterize the methodological limitations and inform interpretation of the pooled findings. All retrieved records were independently screened by two investigators according to predefined inclusion and exclusion criteria. Disagreements or uncertainties regarding eligibility were reviewed and resolved by a third independent reviewer

- Literature search result

A total of 768 reports had titles referencing aneurysmal rupture, of which 286 specifically involved aICH. After restricting the analysis to reports of saccular aICH published from 2000 onward, 93 articles met the eligibility criteria. Of these, 68 were case reports (representing 136 patients) and 25 were case series (representing 2,388 patients), as illustrated in Fig. 1. The results of the literature search are presented in Tables 4–6 and Supplementary Tables 4–6, which summarize the studies containing relevant cases

Results of the Literature Review

- .Step 1: Individual case-report cohort

Case Report Analysis

In the initial phase, we analysed individual case-report cohort with a(ICH). Because no uniform hematoma-volume threshold was consistently reported across the source literature,patients in the case-report cohort were classified according to the radiological description provided in the original publication with absence versus presence of mass effect/midline shift used as the principal distinction where applicable.The following variables were extracted for each patient:

- Demographics (sex and age)
- Hematoma volume and premorbid condition
- Clinical status (CS) at the time of treatment
- Treatment modality
- Aneurysm- treatment interval (A–T) interval (the duration between aneurysmal rupture and treatment)
- Clinical outcome
- Step 2: Case-series cohort

The second phase involved a systematic review of a(ICH) case series. Data extracted from these reports included

- Demographics (sex and age)
- Hematoma volume and premorbid condition
- Clinical status (CS) at the time of treatment
- treatment approach,
- A–T interval
- Clinical outcome

Treatment Timing and Subgroups

Patients from both datasets were categorized into three subgroups based on the A–T interval:

1. Early Treatment (E): treatment within 24 hours of aneurysm rupture (this category included reports providing a treatment interval of ≤ 24 hours, as well as reports explicitly describing treatment as early, emergent, immediate, or performed on the same day, when the reported clinical context supported classification as treatment within 24 hours.)
2. Delayed Treatment (D): treatment > 24–72 hours after aneurysm rupture.
3. Late/unreported treatment (Un ): treatment > 72 hours after rupture or treatment timing not reported.

Clinical Status and Outcome Assessment

Clinical status (CS) is defined as the status recorded at the time of treatment; this means that if a patient was admitted with a good clinical status but their condition subsequently deteriorated, the current status is used as a clinical condition. (CS) was assessed using the Hunt and Hess (H&H) scale, Glasgow Coma Scale (GCS), and the World Federation of Neurosurgical Societies (WFNS) scale. For standardized analysis, patients were dichotomized as follows:

- Good Clinical Status: H&H grades I–III, GCS ≥ 12, WFNS grades 1–3, or qualitative descriptions of mild neurological/mental symptoms.
- Poor Clinical Status: H&H grades IV–V, GCS < 12, WFNS grades 4–5, or qualitative descriptions indicating severe neurological impairment.

Clinical outcomes were evaluated using the modified Rankin Scale (mRS), Glasgow Outcome Scale (GOS), or descriptive categories. For analysis, outcomes were categorized into two groups

- Favorable Outcome: mRS 0–2, GOS 4–5, or descriptions such as "good recovery," "moderate disability," or "neurologically intact at discharge."
- Unfavorable Outcome: mRS 3–5, GOS 2–3, or descriptions such as "severe disability," "vegetative state," "reduced daily functioning," or "permanent deficits."

# Statistical analysis

Data were summarized using absolute counts and percentages. Continuous variables are presented as mean ± standard deviation (SD), whereas categorical variables are expressed as frequencies and percentages. Group differences were analyzed using Pearson's chi-square test or Fisher's exact test, as appropriate. Crude odds ratios (ORs) with 95% confidence intervals (CIs) and corresponding p-values were estimated using univariate logistic regression. Variables with $p < 0.10$ in univariate analysis were entered into multivariable logistic regression models to identify factors independently associated with favorable outcome. Separate multivariable models were constructed for the small-ICH and large-ICH cohorts, with favorable outcome (FO = 1) versus unfavorable outcome or death (UFO + Death = 0) as the dependent variable. Missing data were excluded from individual analyses; therefore, the denominator varied according to data availability for each variable. Statistical significance was defined as a two-sided p-value < 0.05. All statistical analyses were performed using Open Epi software (version 7.2.2.6). Odds ratios for treatment-timing and clinical-status comparisons in the case-series cohort were displayed using forest plots generated with Cochrane Review Manager 5.4

# Results

Study Population and Hematoma Classification

In the case report study, patients were divided into two cohorts: 52 with small hematomas and 84 with large hematomas. In the case series study, parenchymal hemorrhage was identified in 2,388 (20.1%) out of 11,873 cases of ruptured aneurysms. 78.5% of patients had a hematoma classified as large, defined by a reported hematoma volume > 23.6 mL or by the presence of mass effect with midline shift.

The mean age across groups ranged from 52.7 ± 4.6 to 56 ± 1.9 years. A significant female predominance was noted in the large hematoma cohorts in the case report series (61.9%, $p = 0.002$) ,as well as in the case series group (62.7%, $p < 0.001$). Conversely, the gender distribution in the small hematoma group was nearly equal (51.9% female vs. 48.1% male, $p = 0.160$ ). While comorbidities were infrequently recorded in the case report cohort (30% and 11.9%), they were prevalent in the case series (72.3%).Hypertension was the most common condition (47.3%).(Table 7),

# Clinical Status

- Small-ICH case-report cohort : A good clinical status was more frequent (61.5% vs. 38.5%, $p = 0.0019$).There was no significant difference in clinical status within the E subgroup ($p = 0.5$). However, the Un subgroup presented a higher proportion of good clinical status compared to poor clinical status at admission (38.5% vs. 17.4%, $p = 0.003$).
- Large-ICH case-report cohort: A poor clinical status was much more prevalent (79.5% vs. 20.4%, $p < 0.0001$). Both subgroups (E and Un) showed a significant predominance of poor clinical status ($p < 0.001$).

**Note**

Because of the small numbers in the D subgroups (n = 6 and n = 8), these patients were not included in the E-versus-Un statistical comparisons. (Table 8, Fig. 2,3)

- Case-series cohort :In this cohort, a poor clinical status was observed in 57.9% of the patients. Results showed that poor clinical status was predominant in both the E and Un subgroups ($p < 0.001$). In contrast, the D cohort was characterized by significantly lower Hunt and Hess (H&H) scores and (WFNS) scores ($p < 0.001$), indicating a better initial neurological status. Detailed data points are summarized in Table 9 and Fig. 4.

Type of Treatment

- Small-ICH case-report cohort : The distribution between microsurgical treatment(MS) and endovascular treatment(EVT) was not statistically different (53.8% vs. 36.5%, $p = 0.063$ ). Surgical evacuation of the hematoma (SHE) was performed in 31.1% of cases (MS + EVT).
- Large-ICH case-report cohort: The most common type of intervention was (MS), either with or without hematoma evacuation, decompressive craniectomy, or lobectomy, accounting for 78.5% of cases ($p < 0.001$). SHE was performed in 63%(MS + EVT).
- Case-series cohort: the combination of microsurgery with hematoma evacuation and/or decompressive craniectomy was the most common therapeutic strategy, representing 74.9% of cases ($p < 0.0001$). Detailed data points are summarized in Table 10.

Clinical Outcomes

- Small-ICH case-report cohort : Patients in this group had a favorable outcome in 84% of cases, with one reported death (1.9%). Favorable outcomes were observed in both the E and Un subgroups. Early treatment was not significantly associated with favorable outcome compared with the Un subgroup (OR 1.25, 95% CI 0.20–7.60, $p = 0.81$).
- Large-ICH case-report cohort: In contrast, this cohort demonstrated a nearly even split in recovery outcomes; 49.3% achieved favorable outcomes, whereas 50.7% had unfavorable outcomes or died ($p = 0.88$). This balance was similarly reflected in both the E and Un subgroups ($p = 0.49$ and $p = 0.34$). Early intervention was not superior to the Un subgroup(OR 1.39,95%I 0.56–3.47,$p = 0.48$)

(Table 8 and Figs. 2 and 3)

- Case-series cohort: the overall adverse outcomes and mortality rates were significantly higher among all patients ($p < 0.0001$), as well as in both the E and Un subgroups ($p < 0.0001$). D had more favorable observed outcomes than E and Un($p < 0.001$), whereas the E-versus-Un comparison was also statistically significant(< 0.0001); however, when D and Un were combined, the difference between E and the combined group was no longer statistically significant($p = 0.167$**).** See Table 9 and Fig. 4 for more details.

To evaluate clinical status, and the (A–T) interval, univariate and multivariate analyses were conducted to assess factors independently associated with favorable outcome within and between the small (ICH), large (ICH) cohorts, and in the case series patients.

Univariate Analysis Findings

- In the large- and small-ICH cohorts, early treatment was not significantly associated with favorable outcome compared with the Un subgroup (OR 1.46,95%CI 0.59–3.62,p = 0.42 ,OR1.87, 95%CI 0.13–26.32,p = 0.64 respectively). Conversely, a favorable outcome was associated with a better clinical status at treatment for both groups (p = 0.001 and p = 0.006, respectively).
- Multivariable logistic regression was performed separately for the small- and large-ICH cohorts to assess whether the A–T interval and clinical status were independently associated with favorable outcome. In the small-ICH cohort, neither the A–T interval (OR 1.08, 95% CI 0.50–2.31, p = 0.834) nor clinical status (OR 2.03, 95% CI 0.51–8.03, p = 0.311) was independently associated with favorable outcome. Similarly, in the large-ICH cohort, neither the A–T interval (OR 0.75, 95% CI 0.47–1.19, p = 0.22) nor clinical status (OR 2.77, 95% CI 0.93–8.28, p = 0.07) was independently associated with favorable outcome after mutual adjustment. Clinical status showed a trend toward an association with favorable outcome in the large-ICH cohort, but this did not reach statistical significance.

**Note**

Given the limited number of cases in both cohorts (6 and 8), we did not include delayed treatment in our statistical analysis, ensuring our focus remains on the most relevant data

Conclusion Overall, patients with small ICH presented with significantly better clinical status and achieved superior outcomes compared to those with large ICH (OR 6.21,95%CI 2.87–13.44,p > 0.0001 and OR 5.64, 95%CI 2.37–13.42,p < 0.001,respectively) (Table 11).

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- Case-series cohort: Univariate logistic regression analysis was performed using favorable outcome as the dependent variable and clinical status as the predictor. Patients in the D group had significantly greater odds of achieving a favorable outcome compared with those in the E group (OR 2.33, 95% CI 1.72–3.16; p < 0.0001), as well as regarding the subgroup Un (OR 3.39, 95% CI 2.4–4.5 ;p < 0.0001). Patients who underwent early surgery demonstrated better statistical outcomes compared to those with unspecified intervention timing (OR 1.59, 95% CI 1.27–1.82; p < 0.001). However, this finding became statistically non-significant after including subgroup D in the "Un" cohort (OR 1.13; 95% CI 0.95–1.33; p = 0.167). Clinical status was significantly associated with outcome in the case-series cohort (p < 0.001), although the direction and magnitude of this association should be interpreted in the context of the reference categories and the distribution of

patients across treatment-timing groups. For a more detailed analysis, please refer to Table 9 and Fig. 5.

# Discussion

Aneurysmal intracerebral hemorrhage most commonly affects individuals over 50 years of age. Women were disproportionately represented in the large-ICH case-report group and in the case-series cohort, which was in agreement with others (12, 13). The mechanism underlying this distribution cannot be determined from the present analysis.

Size of hematoma

The study identified a strong association between hematoma classification and clinical status. Patients with small intracerebral hemorrhages (ICH) were significantly more likely to be in good clinical condition, while those with large hematomas typically exhibited poor clinical status. This pattern was also noticeable among patients who underwent early surgery. In a case series, 78.5% of the patients had large hematomas, and 58% had poor clinical status. A similar difference was observed in the E subgroup of patients.

The existing literature indicates that the prognostic significance of hematoma volume in a (ICH) is still debated. Generally, a hematoma volume of approximately 25 ml is deemed life-threatening (5, 14–16). Numerous studies have established hematoma size as a strong predictor of poor outcomes(1, 17, 18), especially when the blood clot volume exceeds 50 ml (7, 19). For instance Güresir et al.(1) reported better rehabilitation outcomes for patients with volumes of 50 ml or less compared to those with volumes greater than 50 ml. Furthermore, patients with smaller hematomas (less than 25 ml) achieved more favorable outcomes, aligning with the findings of this analysis (5,8 ).

A multivariate analysis by Jabbarli et al.(7) definitively identified hematoma volume as an independent predictor of adverse outcomes, surpassing the significance of factors such as initial neurological status, age, hydrocephalus, cerebral infarction, systemic inflammatory response syndrome, treatment modality, and vasospasm. Midline shift emerges as a crucial prognostic indicator (8 ), directly reflecting the severity of acute brain injury and demonstrating a stronger association with early mortality than with long-term functional recovery(16). Le Roux et al(16),. established that each unit increase in hematoma volume correlates with a 3% rise in early mortality. This relationship is primarily due to the compressive mass effect, which critically deteriorates outcomes during the acute phase of intracerebral haemorrhage (14). Conversely, Bruder et al. (19 demonstrated that neither hematoma size nor location functions as an independent predictor of outcome. Numerous studies reinforce this conclusion, consistently failing to establish a statistically significant association between hematoma size and clinical outcomes in cases of acute a(ICH) (1,7 ,20–22 ). Therefore, hematoma volume should not be viewed as a standalone prognostic indicator; instead, patient outcomes are shaped by a complex interplay of variables, such as patient age, the occurrence of vasospasms, rebleeding episodes, and cardiopulmonary complications (20, 23).

## Clinical status

As previously noted, clinical status (CS) at the time of treatment differed significantly between the small and large intracranial hematomas. In general, patients with a (ICH) are in poor clinical condition at admission (8, 24, 25). However, neurological status is dynamic; patients admitted in poor condition, if they improve within a few hours, often have a better recovery than those whose condition stagnates over a longer period of time (26). This was evident in our analysis of case reports, where functional outcomes were better than the clinical status .In contrast, the analyzed case series reveal that even patients who appear to have satisfactory clinical status can face unfavorable or fatal outcomes. This underscores the reality that secondary brain injury mechanisms, including cerebral edema, hydrocephalus, vasospasm, and rebleeding, significantly impact the prognosis of stroke.

A recent multivariate analysis by Nguyen et al. (27) clearly demonstrates that clinical status is the most critical prognostic factor. This status directly reflects immediate brain injury resulting from mass effect, increased intracranial pressure, and tissue displacement caused by the hematoma .Some authors, however, raise questions about the strength of this correlation (4, 17, 24), arguing that poor outcomes are primarily determined by the patient's overall clinical condition rather than merely the presence of a parenchymal cerebral clot. Nonetheless, key factors such as intracranial pressure (ICP), time to treatment, and severity of hemorrhage have emerged as stronger prognostic determinants (1, 8, 26). Consistent findings indicate a robust correlation between Hunt and Hess (HH) grade and clinical outcomes; a higher HH grade unequivocally predicts worse outcomes (1). Furthermore, the presence of intraventricular hemorrhage is recognized as an unfavorable prognostic factor, irrespective of the initial clinical grade (8, 16).

## Time of treatment

Direct comparisons between our findings and those in the existing literature reveal significant limitations due to varying definitions of "urgent intervention. While some clinicians define urgent intervention as occurring within six hours, other studies lack precise timeframes and instead use vague terms such as "early surgery," "surgery immediately after diagnosis," "urgent intervention," or "treatment on the day of diagnosis." To address this inconsistency, we have clearly defined our early treatment group as patients who are treated within 24 hours. Comparisons with previous studies are difficult because definitions of early/urgent treatment differ. In the present pooled case-report analysis, early treatment was not associated with significantly better outcome after adjustment for clinical status. In the case-series cohort, treatment > 24–72 hours was associated with more favorable observed outcomes than treatment within 24 hours; however, this association is highly susceptible to confounding by baseline clinical status and treatment selection. Early treatment was associated with more favorable observed outcomes for patients who had surgery in the late/unreported cohort. These patients exhibited similar clinical status. However, when looking at the combined group of patients—which includes those who experienced > 24-72h surgery and those who had late/unreported time of treatment —early surgery does

not provide any advantages. It seems that clinical status, along with other factors, is relevant for the outcomes .

The debate over early surgical intervention in a (ICH) is ongoing. Multiple studies indicate that early surgical hematoma evacuation (SHE) combined with aneurysm occlusion can reduce mortality and enhance recovery, especially in patients with large hematomas (1, 28). Remarkably, individuals with poor neurological status and hematomas larger than 10 mL, once deemed to have a poor prognosis, may still experience favorable recovery when SHE is performed quickly (15). Güresir et al. [1]. advocate for ultra-early SHE, revealing that patients treated within three hours have significantly better outcomes than those treated after seven hours. Similarly, Shimoda et al. [8] identified a six-hour threshold, linking earlier intervention with improved results. These findings suggest that patients in good neurological condition, but with large hematomas, can also benefit from prompt surgical action (1, 9 ,14, 16, 29–31). For some clinicians, the rationale behind early intervention is to lower intracranial pressure, prevent rebleeding, and improve cerebral perfusion, thereby contributing to better recovery and quality of life for individuals who have suffered an intracerebral hemorrhage (ICH). (32, 33).

Despite these findings, the benefit of early intervention remains controversial in patients presenting with severe neurological deterioration or signs of brain herniation, largely due to limited and inconsistent clinical evidence [34 ]. Nemoto M et al. [20] found no significant association between time from hemorrhage onset to treatment and prognosis. Consequently, many authors recommend individualizing surgical timing based on clinical grade, favoring early intervention in patients with better neurological status and delayed treatment in those with poor-grade presentation [9, 32 ,35 ,36 ]. In a large cohort of 1,125 patients with aneurysmal ICH, Wan BN et al. [23 ] reported no causal relationship between the aneurysm-to-treatment interval and outcome, paradoxically noting worse outcomes in patients treated within six hours compared with those treated later. The available evidence therefore does not establish an optimal universal treatment interval.

Type of treatment

Treatment for patients with small aneurysmal intracerebral hematomas is generally evenly split between MS and EV. In contrast, those with large intracerebral hemorrhages (ICH) are mainly treated with a combination of aneurysm clipping and surgical procedures like hematoma evacuation or decompressive craniectomy.

A randomized prospective trial has shown that hematoma evacuation via aneurysm clipping can reduce mortality by nearly two-thirds (28). Patients with large hematomas are therefore typically managed surgically, particularly when additional procedures such as SHE or decompressive craniectomy are required (37) .Thus, surgical intervention is often necessary for large hematomas, especially if imminent herniation is evident. In such cases, urgent decompression and evacuation are critical to preventing early mortality. Additionally, Talamonti et al (14). reported significantly better six-month outcomes with aneurysm clipping, reducing adverse effects in patients with life-threatening hematomas. However, open surgical methods may increase the risk of complications like pulmonary infections and cardiac failure.(

38 ]. This highlights the need for further prospective randomized studies to clarify the role of SHE in treating poor-grade a( ICH)(39).

Endovascular therapy is increasingly recognized as an effective initial option for certain patients to prevent intraoperative aneurysm rupture, particularly in older individuals, those with poor neurological status, and patients with posterior circulation aneurysms. [40–42 ]. Hara et al. .(43) showed that successful endovascular treatment of anterior circulation aneurysms could be achieved without surgical clot evacuation, suggesting that evacuation may be unnecessary for localized, non-compressive hematomas without signs and symptoms of herniation. This approach, involving limited clot decompression followed by endovascular occlusion, has the potential to reduce surgical time. In a study by de los Reyes et al44). involving 25 patients, mortality rates, complication rates, and overall costs were similar for patients undergoing endovascular therapy with surgical hematoma evacuation compared to those receiving (MS + SHE),although clot removal took nearly twice as long in the endovascular group. Several studies also have shown that treatment modality alone does not significantly influence overall outcome [2,44 ,45).

Outcome

Clinical outcomes clearly differ between patients with small and large hematomas. Those with small intracerebral hemorrhages (ICH) generally have favorable outcomes, while large ICHs are associated with significantly poorer prognoses. The case-series cohort shows even less favorable outcomes compared to those in the large ICH group of the case-report series. This case series indicates that **more favorable observed functional outcomes were reported** in patients undergoing microsurgery (MS) or an endovascular treatment (EVT) within the (D ) subgroup. On the other hand, early surgical intervention proved statistically superior compared to the late/unreported cohort. It is important to note that patients in the > 24-72hours - group had a better clinical status to those in the other subgroups, which may partially explain the observed results. Notably, patients presenting with good clinical status in the case-series cohort frequently experienced unfavorable outcomes, a pattern that was not observed among the case-report populations.

Aneurysmal intracerebral hemorrhage is a severe condition that often leads to poor neurological status, high mortality, and limited recovery (1, 3, 23, 24). Abbed et al.. [24] reported that only 37% of patients achieve good or excellent recovery, while 28% have satisfactory or poor outcomes, with a mortality rate of 34%. Additionally, aggressive treatment strategies can yield acceptable outcomes even for those with severe neurological impairment (1, 2, 46, 47). Multivariate analyses from several studies have identified younger age, better neurological condition at admission, and the absence of cerebral herniation as independent predictors of favorable outcome [19].Guresir et al. [1] found that nearly half of the patients experienced favorable outcomes, even though about 40% were in poor condition upon admission. This illustrates the effectiveness of treating large hematomas (over 50 $cm^3$) through early surgical evacuation and aneurysm clipping. Notably, early neurological improvement within the first 72 hours is a strong predictor of recovery [16], likely due to the benefits of timely decompression [1]. However, patients who

initially appear neurologically stable may later experience deterioration, as seen in our case series. This decline is often linked to secondary brain injury mechanisms, such as hematoma compression, increased intracranial pressure, cerebral edema, subsequent hydrocephalus, vasospasm, and incidental rebleeding ([1, 4, 5, 17, 48). While thorough evacuation can reduce mass effect and complications [14], the extent of clot removal in patients in poor condition has a limited impact on prognosis [49]. Additionally, Yang et al. [49] identified advanced age, low admission grade, and intraoperative vascular injury as key predictors of adverse outcomes.

Several limitations must be acknowledged. The 2000–2025 time frame prioritizes modern clinical standards but naturally excludes long-term historical data. Additionally, the systematic analysis was challenged by the inherent heterogeneity of the source material. The findings should be interpreted cautiously because the data were derived from published case reports and case series.Several cases have appeared as illustrative examples within a case report series, as well as within a patient series analyzed as part of a case series. Heterogeneity in patient selection, treatment strategies, reporting practices, and follow-up may have introduced residual confounding and selection bias. Consequently, the observed associations should be considered hypothesis-generating rather than evidence of causality. Treatment timing was often incompletely or imprecisely reported. Many authors employed divergent variables in their outcome assessments, and the presence of missing data and reporting inconsistencies across publications may affect the overall synthesis of the results.

# Conclusion

Hematoma size is linked to clinical status and patient outcomes. Patients with small ICH reported more favorable outcomes compared to those with large ICH and the case series patients. The predominant treatment for large ICH and case series patients was aneurysm clipping combined with SHE, a combination that was less commonly observed in small ICH cases.

In the current pooled case-report analysis, early treatment did not show a significantly better outcome after adjusting for clinical status. In the case-series cohort, treatment administered > 24–72 hours was associated with more favorable outcomes compared to treatment within the first 24 hours. However, this association is highly susceptible to confounding by baseline clinical status and treatment selection. While E treatment showed better outcomes than treatment in the "Un" group, this significance diminished when the "D" and "Un" groups were combined. Notably, a significant number of patients who were admitted in good clinical condition experienced poor recovery.

# Abbreviations

E (early)- ≤ 24 hours treatment,

D (delayed) )->24--72  treatment ,

Un**- >72 hours or unreported treatment**,

CS- Clinical status,

CSE- clinical status of E treatment,

CSD- clinical status of D treatment,

CS Un- clinical status Un treatment,

TCS- total clinical status

TCSS-total clinical status small ICH

TCSL-total clinical status large ICH

O-outcome,

OE-outcome of E treatment,

OD- outcome of D treatment,

O Un- outcome of Un treatment,

TOS-total outcome small ICH

TOL-total outcome large ICH

FO favourable outcome

UFO unfavourable outcome,

Death

HTA-hypertension,

DM-diabetes mellitus,

CVS- previous cerebrovascular stroke

G- good,

P- poor ,

LICH-large ICH,

SICH-small ICH

NA-not available.

OR-Odds ratio

DC-decompressive craniectomy ;

MS microsurgical treatment (-clipping &clipping +SHE , aneurysms resection, coagulation, trapping);

SHE-surgical hematoma evacuation

EVT-endovascular treatment (coling &coiling SHE)

Others : Ventriculo- peritoneal  shunt, ,Extra ventricular drainage, Conservative treatment,

No TR-no treatment

Plo.-partial lobectomy,

Vs-ventriculostomy;

EVD-extra ventricular drainage.

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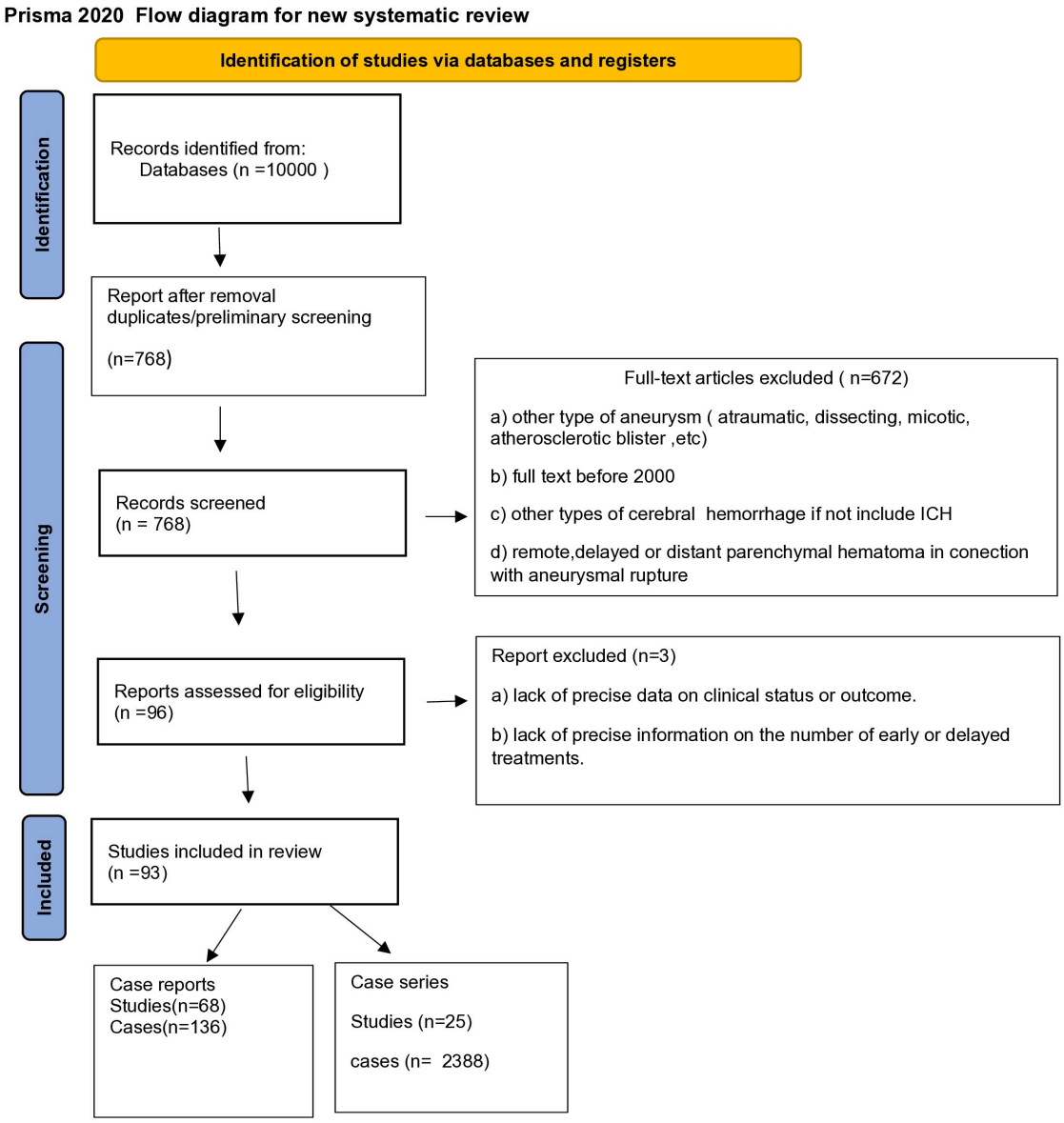
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## Tables

Tables 1 to 11 are available in the Supplementary Files section.

## Figures

Fig 1




## Figure 1

Flow diagram for case report and case series of patients

Fig 2

Small ICH

Clinical status and outcomes according to treatment timing in patients with small ICH

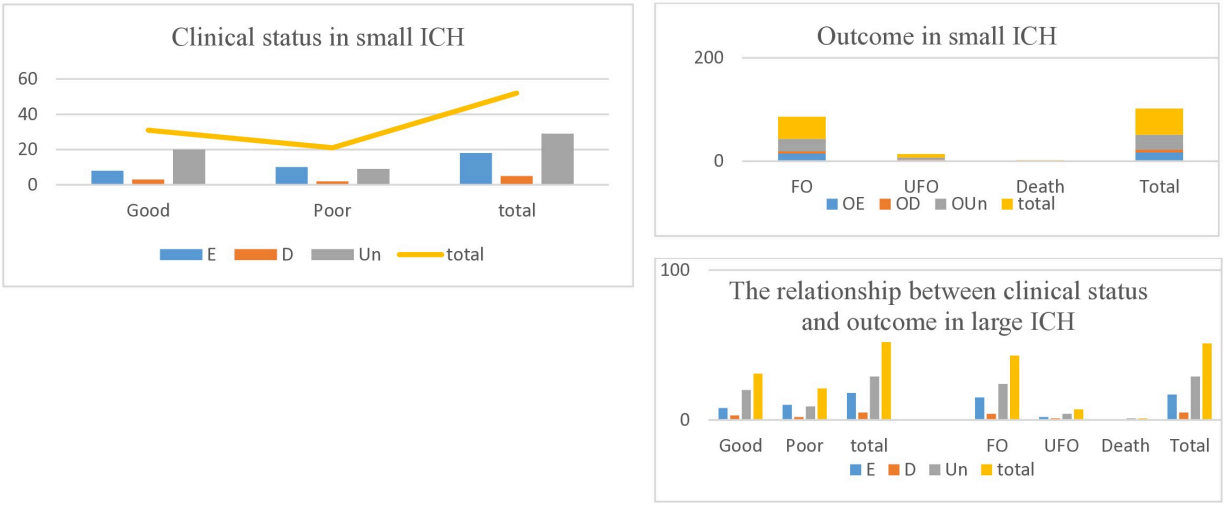


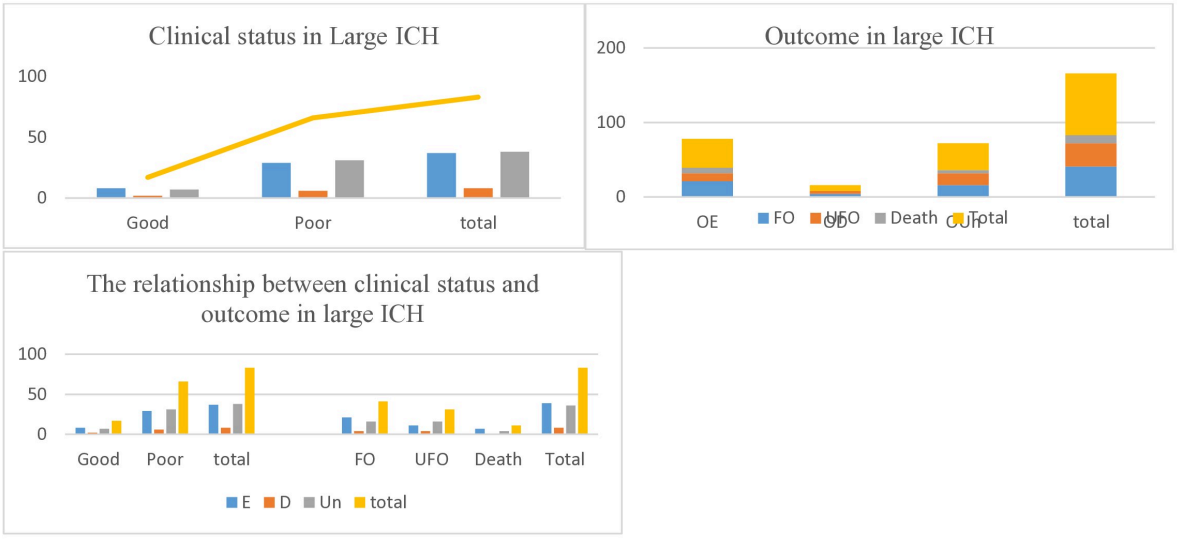

**Figure 2**

Clinical status and outcomes according to treatment timing in patients with small ICH

Fig 3

Large ICH

Clinical status and outcomes according to treatment timing in patients with large ICH

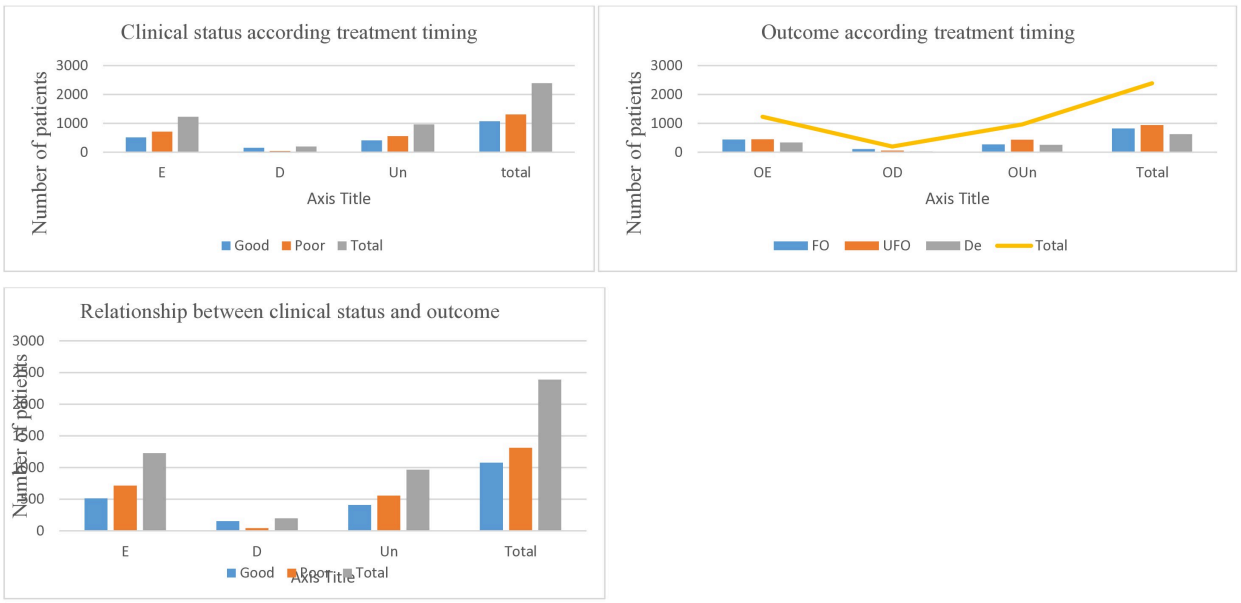



## Figure 3

Clinical status and outcomes according to treatment timing in patients with large ICH

Fig 4

Clinical status and outcomes according to treatment timing in case series patients




## Figure 4

Clinical status and outcomes according to treatment timing in case series patients

**Fig 5**

**Odds ratios for clinical status and treatment-timing subgroups in the case-series cohort**

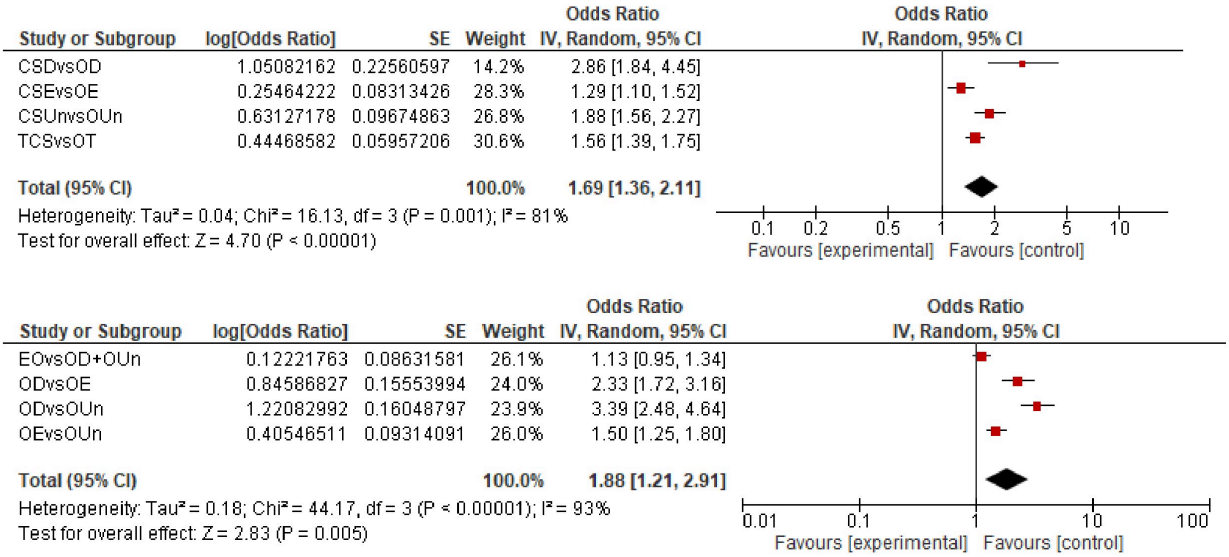



**Figure 5**

Odds ratios for clinical status and treatment-timing subgroups in the case-series cohort

# Supplementary Files

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- Table1.docx
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- Table9.docx
- Table10.docx

- Table11.docx
- SupplementoftheTable4and5.docx
- SupplementoftheTable6.docx