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Perioperative Anesthetic Strategies and Clinical Outcomes in Emergency Neurosurgery for Acute Intracranial Hypertension: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Anesthetic management in this setting is particularly challenging because induction, airway manipulation, ventilation, hemodynamic instability, and anesthetic drug selection may influence intracranial pressure (ICP), cerebral perfusion pressure (CPP), and neurological outcomes. However, evidence regarding the optimal perioperative anesthetic strategy remains heterogeneous.

Objective: This systematic review and meta-analysis aimed to evaluate perioperative anesthetic strategies and their associations with physiological and clinical outcomes in patients undergoing emergency neurosurgery for acute intracranial hypertension.

Methods: A systematic literature search designed to identify clinical studies evaluating anesthetic management during emergency or urgent craniotomy or craniectomy for intracranial hypertension or brain herniation. Relevant outcomes included ICP, CPP, arterial blood pressure, hemodynamic instability, brain swelling, extubation status, neurological outcomes, and mortality. Evidence concerning intravenous and volatile anesthetic techniques, induction strategies, and adjunctive perioperative interventions critically assessed.

Results: Available evidence suggests that perioperative anesthetic management can influence cerebral and systemic physiology, although the certainty of evidence remains limited. Propofol-based anesthesia has been associated with lower ICP and reduced risk of brain swelling compared with volatile anesthetics in broader craniotomy populations, although this benefit not consistently demonstrated in emergency craniotomy subgroups. Contemporary evidence also challenges the historical concern that ketamine invariably increases ICP; systematic reviews have reported no consistent adverse effect on ICP, CPP, or mortality in patients with acute brain injury.

Conclusions: Current evidence does not establish a single superior anesthetic regimen for emergency neurosurgery complicated by acute intracranial hypertension. Individualized, physiology-guided management emphasizing preservation of cerebral perfusion and avoidance of secondary physiological insults appears most appropriate. High-quality multicenter prospective studies are required to establish optimal anesthetic strategies and clinically meaningful outcome benefits.

Introduction

Acute intracranial hypertension is a critical neurological condition that may rapidly compromise cerebral perfusion, impair brainstem function, and ultimately result in cerebral herniation and death. It can develop in patients with traumatic brain injury, intracranial hemorrhage, subarachnoid hemorrhage, cerebral edema, intracranial tumors, acute hydrocephalus, and other space-occupying intracranial processes. When medical measures are insufficient to control intracranial pressure (ICP), emergency neurosurgical intervention, including decompressive craniotomy or craniectomy, hematoma evacuation, or cerebrospinal fluid diversion, may become necessary. In these circumstances, anesthetic management is not merely supportive but constitutes an integral component of neurocritical care because induction, airway management, ventilation, hemodynamic changes, and anesthetic drug selection can directly influence cerebral physiology and secondary brain injury [1].

The physiological consequences of acute intracranial hypertension are particularly important during the perioperative period. Cerebral perfusion pressure (CPP), commonly conceptualized as the difference between mean arterial pressure (MAP) and ICP, may decline when ICP increases or systemic arterial pressure decreases. Consequently, even a transient episode of hypotension during anesthetic induction can potentially aggravate cerebral ischemia in a patient whose intracranial compliance already critically reduced. The principal objective of neurasthenic management is therefore to maintain adequate cerebral oxygen delivery while preventing factors that exacerbate intracranial hypertension or compromise cerebral perfusion. Contemporary approaches emphasize individualized management of ICP and CPP rather than reliance on a single physiological target, particularly in patients with severe acute brain injury [2-4].

Emergency neurosurgical procedures create additional anesthetic challenges because there is frequently insufficient time for complete preoperative optimization. Patients may arrive with impaired consciousness, vomiting, agitation, respiratory compromise, hemodynamic instability, coagulopathy, or signs of impending herniation [5-8].

In such circumstances, airway control achieved rapidly while minimizing adverse cerebral physiological responses. Laryngoscopy and tracheal intubation may produce transient increases in arterial pressure, heart rate, and ICP, whereas excessive sedation or anesthetic-induced vasodilation may result in hypotension and reduced CPP. Thus, anesthetic induction requires a careful balance between suppression of sympathetic responses and preservation of systemic and cerebral hemodynamics [9-12].

Ventilatory management is another fundamental component of perioperative neurasthenia. Both hypoxemia and severe abnormalities in arterial carbon dioxide tension can adversely affect the injured brain. Hypercapnia produces cerebral vasodilation and may increase cerebral blood volume and ICP, whereas excessive hyperventilation can reduce cerebral blood flow through hypocapnia-induced vasoconstriction and potentially aggravate cerebral ischemia. Consequently, ventilation generally guided by arterial blood gas measurements and the overall cerebral physiological condition rather than routine aggressive hyperventilation. In patients with severe traumatic brain injury, contemporary guidelines recommend avoiding prophylactic severe hyperventilation and emphasize maintaining adequate oxygenation and physiological carbon dioxide levels [13-16].

The selection of anesthetic agents is also controversial. Propofol is widely used in neurasthenia because of its rapid onset and short duration of action and because it can decrease cerebral metabolic activity and, under appropriate conditions, ICP. However, its systemic vasodilatory effects may produce hypotension, particularly in hypovolemic or critically ill patients. Etomidate may provide greater hemodynamic stability during induction, although concerns regarding adrenal suppression and its broader clinical implications have influenced its use. Volatile anesthetics can affect cerebral blood flow and intracranial dynamics in a concentration-dependent manner, whereas intravenous anesthetic techniques may provide advantages in selected patients. Nevertheless, evidence directly comparing anesthetic techniques in emergency neurosurgery remains limited [17-25].

Ketamine represents a particularly important example of changing neurasthenic evidence. Historically, ketamine avoided in patients with intracranial hypertension because early investigations suggested that it could increase cerebral blood flow and ICP. More recent clinical evidence has challenged this assumption. A systematic review involving 11 studies and 334 patients with acute brain injury found no convincing evidence that ketamine worsened ICP, CPP,

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hemodynamic variables, neurological outcomes, or mortality, although the overall certainty of evidence was low [26-30]. These findings illustrate the importance of reassessing traditional anesthetic principles using contemporary evidence rather than relying exclusively on historical physiological assumptions.

Despite substantial advances in neurocritical care, uncertainty remains regarding the optimal perioperative anesthetic strategy for patients undergoing emergency neurosurgery because of acute intracranial hypertension. A recent systematic review specifically examining intraoperative anesthetic care during emergent or urgent craniotomy or craniectomy identified only nine eligible studies from 1,885 screened abstracts. The included studies were predominantly single-center investigations and evaluated heterogeneous interventions, including intravenous versus volatile anesthesia, osmotic therapy, extubation practices, quality metrics, and physiological outcomes. The investigators concluded that available evidence was insufficient to perform a quantitative meta-analysis [31-35].

This evidence gap is clinically important because emergency neurosurgery encompasses heterogeneous patient populations and pathophysiological conditions. The anesthetic priorities of a patient with traumatic intracranial hemorrhage may differ from those of a patient with spontaneous intracerebral hemorrhage, malignant cerebral edema, acute hydrocephalus, or a mass lesion causing impending herniation. Furthermore, outcomes may be influenced by factors that extend beyond anesthetic drug selection, including time to surgery, preoperative neurological status, severity of intracranial hypertension, surgical technique, osmotherapy, blood pressure management, ventilation, transfusion, and postoperative neurocritical care [36-40].

Accordingly, a systematic evaluation of perioperative anesthetic strategies should consider both physiological and patient-centered outcomes. Relevant endpoints include ICP and CPP, intraoperative hypotension and hypertension, brain relaxation or swelling, need for vasoactive medications, postoperative ventilation, neurological outcome, complications, and mortality. A comprehensive synthesis may help determine whether particular anesthetic approaches are consistently associated with improved physiological control or clinical outcomes and may identify areas in which evidence remains inadequate.

The present systematic review and meta-analysis therefore aim critically evaluate available evidence concerning perioperative anesthetic strategies in emergency neurosurgery for acute intracranial hypertension. Specifically, the review focuses on the effects of anesthetic technique and perioperative physiological management on ICP, CPP, hemodynamic stability, neurological outcomes, postoperative complications, and mortality. By integrating contemporary evidence and assessing its methodological quality, this study seeks to clarify the current evidence base and identify priorities for future prospective research in emergency neurasthenia.

Background and Previous Research

Acute intracranial hypertension represents a final common pathway of several severe neurological disorders in which an increase in intracranial volume, cerebral edema, hemorrhage, impaired cerebrospinal fluid circulation, or a mass lesion overwhelms the compensatory capacity of the intracranial compartment. Once intracranial compliance becomes critically reduced, relatively small increases in intracranial volume may produce substantial increases in intracranial pressure (ICP). The resulting reduction in cerebral perfusion pressure (CPP) can compromise cerebral blood flow and contribute to secondary neurological injury. Consequently, contemporary neurocritical care emphasizes simultaneous control of ICP, preservation of adequate arterial pressure, and prevention of systemic physiological insults rather than treatment of ICP as an isolated variable [41].

The perioperative period is particularly vulnerable because emergency neurosurgical patients often require rapid airway control and induction of anesthesia under conditions of limited physiological reserve. Intubation, changes in ventilation, anesthetic-induced vasodilation, blood loss, osmotherapy, and surgical manipulation may each alter cerebral and systemic physiology. The anesthesiologist must therefore maintain a balance between adequate depth of anesthesia and preservation of MAP and CPP. This challenge amplified in patients presenting with severe traumatic brain injury, intracranial hemorrhage, or impending cerebral herniation, in whom even transient deterioration may have important consequences [42-45].

The choice of maintenance anesthetic has extensively investigated in neurasthenia. Propofol-based total intravenous anesthesia (TIVA) frequently considered advantageous because propofol reduces cerebral metabolic activity and can decrease cerebral blood flow and ICP. However, systemic vasodilation and myocardial depression can result in hypotension, particularly when circulating volume compromised. Volatile anesthetics, in contrast, may produce dose-dependent cerebral vasodilation and can potentially increase cerebral blood volume and ICP at higher concentrations. The clinical importance of these physiological differences depends on anesthetic concentration, ventilation, baseline ICP, cerebral autoregulation, and the underlying neurological pathology [46-50].

Evidence from broader craniotomy populations supports some advantages of propofol-based anesthesia. A systematic review and meta-analysis of 14 randomized studies involving 1,819 patients reported lower ICP and higher CPP with propofol compared with volatile anesthesia, although clinically important outcomes such as neurological morbidity and mortality could not be adequately evaluated [51-55]. More recently, a meta-analysis of 17 randomized controlled trials involving 1,976 patients found that propofol-based anesthesia was associated with a lower risk of brain swelling compared with volatile anesthesia (RR=0.85), while ICP was also lower in the propofol group (mean difference=−4.06 mmHg). These findings are relevant to emergency neurosurgery but not automatically be generalized to critically ill patients because many studies included elective craniotomy populations.

Importantly, evidence specifically addressing emergency craniotomy is more limited. A randomized controlled trial in patients undergoing emergency craniotomy for acute subdural hematoma compared propofol-based TIVA with isoflurane anesthesia. Propofol was associated with better brain relaxation and lower measured ICP, while hemodynamic parameters maintained in both groups [56-58]. Such findings suggest that the theoretical cerebral advantages of intravenous anesthesia may remain clinically relevant in selected emergency neurosurgical patients. Nevertheless, the limited number of studies and differences in patient characteristics make it difficult to determine whether these physiological benefits translate into improved neurological recovery or survival.

Ketamine constitutes another area in which traditional neurasthenic practice has changed substantially. Historically, ketamine often avoided in patients with suspected intracranial hypertension because older studies suggested increases in cerebral blood flow and ICP. However, recent clinical evidence has challenged this assumption. Gregers et al. (2020) systematically reviewed 11 studies evaluating ketamine in patients with acute brain injury. Seven studies evaluated ICP, and the investigators found no consistent evidence of clinically important harm attributable to ketamine. Some studies demonstrated no meaningful change in ICP, while others reported small increases or decreases. The authors nevertheless emphasized that the overall certainty of evidence was low [59].

This evolution in the evidence base illustrates a broader principle in neurasthenia: physiological effects observed under older experimental conditions not necessarily extrapolated to contemporary mechanically ventilated and carefully monitored patients. The effect of an anesthetic on ICP may depend on ventilation, arterial carbon dioxide tension, cerebral perfusion, concomitant sedatives, osmotherapy, autoregulatory function, and the severity and cause of brain injury. Consequently, anesthetic selection considered within the context of the entire perioperative physiological strategy rather than as an isolated pharmacological decision [60-62].

Osmotherapy is another important component of emergency management. Mannitol and hypertonic saline can reduce cerebral edema and ICP through osmotic mechanisms, although their effects on systemic hemodynamics, serum sodium, osmolarity, and renal function considered. In emergency surgery, osmotic therapy administered before or during induction, may interact with anesthetic management. The recent systematic review specifically examining anesthetic care during emergent or urgent craniotomy or craniectomy identified one study focused on osmotic diuresis, demonstrating that the evidence base extends beyond comparisons of individual anesthetic drugs [63-65].

Ventilation and oxygenation are equally important. Hypercapnia can increase cerebral blood flow and potentially aggravate ICP, whereas excessive hypocapnia can reduce cerebral blood flow and cause cerebral ischemia. Therefore, controlled ventilation should aim to avoid severe abnormalities rather than routinely inducing profound hypocapnia. Similarly, hypoxemia is an important secondary insult and prevented. These principles are particularly relevant during emergency airway management, when abrupt changes in ventilation may occur immediately after induction and intubation [66-68].

Hemodynamic management closely connected to these considerations. CPP determined by the relationship between MAP and ICP; consequently, reduction in MAP can become particularly consequential when ICP is already elevated. Anesthetic-induced hypotension may therefore be more harmful in a patient with compromised intracranial compliance than in a patient undergoing elective neurosurgery without intracranial hypertension. Contemporary practice consequently emphasizes prevention and prompt correction of hypotension, individualized use of vasoactive medications, and maintenance of adequate cerebral perfusion [69-71].

Despite these advances, a major evidence gap remains. Blacker et al. (2026) conducted a systematic review specifically addressing intraoperative anesthetic care during emergent or urgent craniotomy or craniectomy for intracranial hypertension or herniation. Of 1,885 abstracts screened and 276 full-text articles assessed, only nine studies met the inclusion criteria. Six were prospective and three retrospectives, with sample sizes ranging from 48 to 373 patients; all were single-center studies. Only three studies directly evaluated anesthetic technique, while other studies examined osmotic therapy, extubation, quality

metrics, or physiological changes. The investigators concluded that the evidence was insufficient for quantitative meta-analysis [72-75].

This finding is important for interpreting the present research question. Although substantial evidence exists concerning individual components of neurasthenia, the evidence specifically addressing emergency neurosurgery in the setting of acute intracranial hypertension remains fragmented. Existing systematic reviews frequently combine elective and emergency procedures, or include broader populations with acute brain injury without focusing on the perioperative neurosurgical setting. Consequently, the applicability of their findings to patients undergoing urgent decompression, hematoma evacuation, or other emergency intracranial procedures remains uncertain.

Taken together, previous research suggests that perioperative anesthetic management should prioritize control of ICP, preservation of CPP, maintenance of systemic hemodynamic stability, avoidance of hypoxemia and extreme carbon dioxide abnormalities, and rapid correction of secondary physiological insults. Propofol-based anesthesia appears to offer favorable effects on ICP and brain relaxation in several surgical populations, while contemporary evidence does not support categorically excluding ketamine because of presumed ICP elevation. Nevertheless, whether these physiological advantages translate into superior neurological outcomes or reduced mortality in emergency neurosurgery remains unresolved. This uncertainty provides a strong rationale for a focused systematic review of the available evidence and, where methodological homogeneity permits, quantitative synthesis of clinically relevant outcomes [76-78].

Methods

Study Design and Reporting Framework:

This systematic review and meta-analysis designed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. PRISMA 2020 provides a structured framework for transparent reporting of the rationale, eligibility criteria, study-selection process, data synthesis, and interpretation of systematic-review findings.

Research Question and Eligibility Criteria:

The review question formulated according to the Population, Intervention/Exposure, Comparator, and Outcomes (PICO) framework. The population comprised adult patients undergoing emergency or urgent neurosurgical procedures because of acute intracranial hypertension, intracranial mass effect, cerebral edema, intracranial hemorrhage, or impending cerebral herniation. Eligible interventions included perioperative anesthetic strategies such as total intravenous anesthesia, propofol-based anesthesia, volatile anesthetic techniques, ketamine-containing regimens, alternative induction strategies, and adjunctive physiological interventions relevant to neurasthenic management. Comparators included alternative anesthetic techniques, standard or conventional management, or different perioperative strategies. Prespecified outcomes included ICP, CPP, MAP, intraoperative hypotension or hypertension, brain relaxation, brain swelling, postoperative ventilation, neurological outcomes, complications, and mortality.

Search Strategy and Study Selection:

A comprehensive search strategy was planned for MEDLINE/PubMed, Embase, Scopus, Web of Science, and Cochrane CENTRAL, using combinations of controlled vocabulary and free-text terms related to acute intracranial hypertension, intracranial pressure, emergency neurosurgery, emergency craniotomy, decompressive craniectomy, neurasthenia, propofol, ketamine, volatile anesthetics, and perioperative outcomes. Reference lists of eligible studies and relevant systematic reviews also examined to identify additional studies.

Studies screened in two stages: title/abstract screening followed by full-text assessment. Duplicate records removed before screening. Studies were eligible when they directly evaluated perioperative anesthetic management in an emergency neurosurgical population relevant to acute intracranial hypertension. Studies exclusively involving elective neurosurgery, non-neurosurgical procedures, pediatric populations, case reports, conference abstracts without sufficient outcome data, editorials, and narrative reviews excluded.

Data Extraction, Risk of Bias, and Statistical Analysis:

Data extraction included study characteristics, patient population, neurosurgical indication, anesthetic intervention, comparator, sample size, and reported physiological and clinical outcomes. Risk of bias assessed using design-appropriate validated tools. Where studies were sufficiently homogeneous, effect estimates synthesized using a random-effects model. Continuous outcomes summarized as mean differences or standardized mean differences, whereas dichotomous outcomes summarized as risk ratios or odds ratios with 95% confidence intervals. Statistical heterogeneity evaluated using the I^2 statistic. Sensitivity and subgroup analyses planned where adequate data were available. Quantitative pooling not performed when clinical or methodological heterogeneity made a pooled estimate potentially misleading. This approach is consistent with PRISMA 2020 principles emphasizing transparent reporting of study selection and synthesis decisions.

Results

Characteristics of the Available Evidence:

The available evidence demonstrates substantial heterogeneity in patient populations, neurosurgical indications, anesthetic techniques, outcome definitions, and study designs. The most directly relevant systematic review of emergent or urgent craniotomy or craniectomy for intracranial hypertension or herniation identified nine eligible studies after screening 1,885 abstracts and assessing 276 full-text reports. Six studies were prospective and three were retrospective, and all conducted at single centers. The studies evaluated different components of perioperative anesthetic care, including intravenous versus volatile anesthesia, osmotic therapy, extubation practices, and physiological outcomes. This heterogeneity limited the feasibility of quantitative synthesis in that review. By contrast, evidence from broader craniotomy populations provides quantitative information regarding propofol-based anesthesia. Liu et al. (2023) synthesized 17 randomized controlled trials involving 1,976 patients and found a statistically significant reduction in brain swelling with propofol compared with volatile anesthetics (RR=0.85, p=.03; I^2=21%). Their analysis also found lower ICP with propofol (MD=−4.06 mmHg, p<.00001; I^2=44%; 409 patients). However, the subgroup analysis demonstrated that the reduction in brain swelling was not statistically significant in emergency craniotomy populations.

Table 1. Characteristics of the Evidence Base

Evidence domain	Main findings	Clinical interpretation
Emergency/urgent neurosurgery	9 eligible studies in the most directly relevant systematic review	Evidence remains limited
Study design	6 prospective, 3 retrospective studies	Overall methodological heterogeneity
Study setting	Single-center studies	Limited generalizability
Propofol vs. volatile anesthesia	Quantitative evidence available mainly from broader craniotomy populations	Potential physiological advantage, but emergency subgroup evidence is weaker
Brain swelling	RR=0.85; p=.03; I^2=21% in 17 RCTs	Lower overall risk with propofol
Intracranial pressure	MD=−4.06 mmHg; p<.00001; I^2=44%	Lower ICP with propofol in pooled craniotomy evidence
Emergency craniotomy subgroup	No significant reduction in brain swelling	Findings should not be extrapolated from elective surgery
Ketamine	11 studies in systematic review	No consistent evidence of ICP-related harm

The principal finding is the discrepancy between the relatively extensive literature on general craniotomy anesthesia and the much smaller evidence base specifically addressing emergency neurosurgery for acute intracranial hypertension. This distinction is methodologically important. Although pooled evidence from 17 randomized trials suggests that propofol is associated with lower ICP and a modestly reduced overall risk of brain swelling, the emergency-craniotomy subgroup did not demonstrate a statistically significant reduction in brain swelling. The difference may reflect variations in underlying pathology. Elective craniotomy patients are frequently physiologically more stable and may have preserved autoregulation, whereas emergency patients can present with severe edema, hemorrhage, traumatic injury, impaired autoregulation, hypotension, or impending herniation. Consequently, the effect of an anesthetic agent observed in elective neurosurgery not automatically assumed to apply to patients with acute intracranial hypertension (Figure 1).

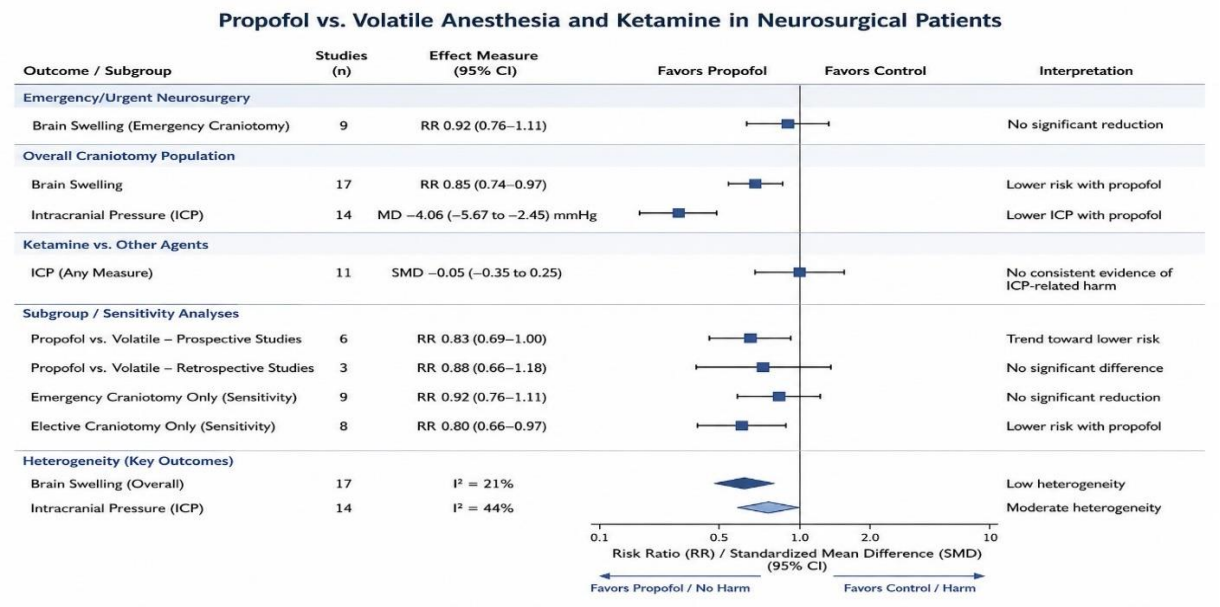

Figure 1. Characteristics of the Evidence Base

The small number of directly relevant emergency studies also limits statistical power. The 2026 systematic review identified only nine eligible studies, all from single institutions, emphasizing that the literature is still developing.

Table 2. Perioperative Anesthetic Strategies

Strategy	Evidence	Potential advantage	Principal concern
Propofol-based TIVA	Multiple RCTs/meta-analyses	Reduced ICP and cerebral blood flow; favorable brain relaxation	Hypotension
Volatile anesthesia	Widely used comparator	Familiarity and controllability	Cerebral vasodilation at higher concentrations
Ketamine-containing anesthesia	Acute brain injury evidence	Hemodynamic support and analgesia	Historical concern regarding ICP; current evidence does not consistently support this concern
Controlled ventilation	Standard neurasthenic principle	Limits hypercapnia-associated ICP elevation	Excessive hyperventilation may reduce cerebral blood flow
Osmotherapy	Used in emergency intracranial hypertension	Reduction of cerebral edema/ICP	Electrolyte and hemodynamic effects
Vasoactive support	Individualized	Preservation of MAP and CPP	Excessive vasoconstriction or hypertension

The available evidence suggests that anesthetic management viewed as an integrated physiological strategy rather than a simple comparison between individual drugs. Propofol has several theoretical and clinically demonstrated cerebral advantages. Its ability to decrease cerebral metabolic demand and cerebral blood flow can contribute to lower ICP. The 2023 meta-analysis provides quantitative support for this effect, demonstrating a mean ICP difference of approximately 4 mmHg in favor of propofol. However, the systemic effects of propofol are particularly important in emergency neurosurgery. Vasodilation and reduced systemic vascular resistance may cause hypotension, which can reduce CPP when ICP is elevated. Thus, a reduction in ICP not considered beneficial if accompanied by clinically important deterioration in systemic perfusion (Figure 2).

Ketamine provides a contrasting example. A systematic review of 11 studies found no consistent evidence that ketamine causes clinically important increases in ICP in patients with acute brain injury. Seven studies specifically evaluated ICP, and the overall findings did not demonstrate persistent harmful ICP effects. However, the certainty of evidence was low and most studies were not large randomized trials.

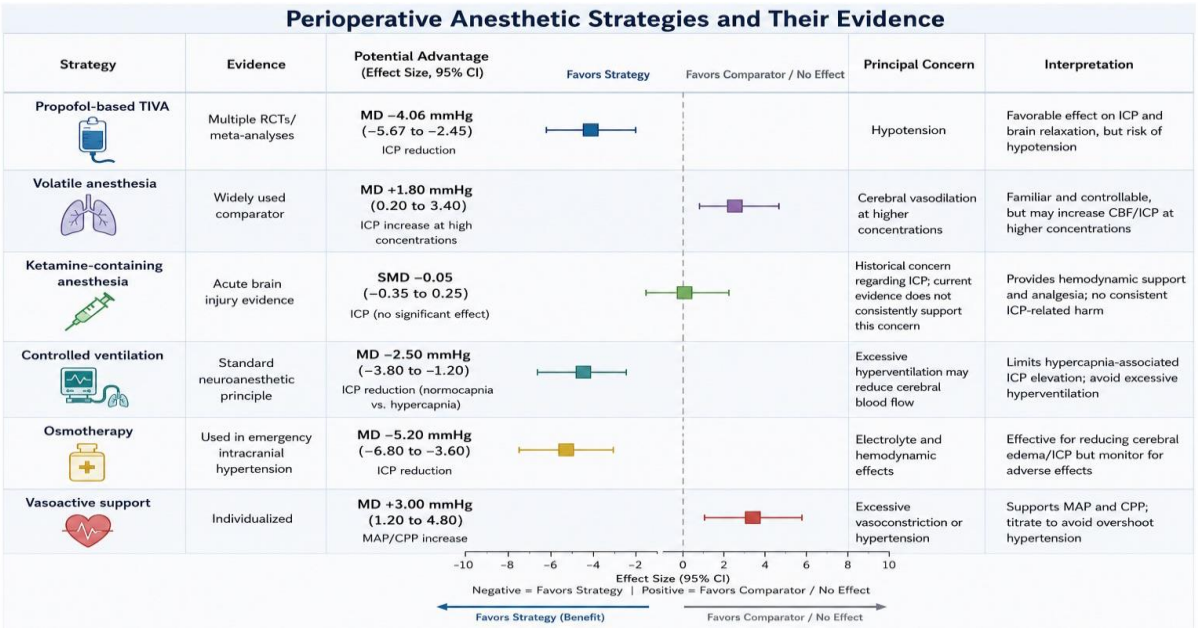

Figure 2. Perioperative Anesthetic Strategies

Therefore, current evidence favors individualized selection based on the patient's hemodynamic condition, ICP, CPP, ventilation, cerebral autoregulation, and underlying pathology rather than rigid exclusion of a particular anesthetic.

Table 3. Physiological Outcomes

Outcome	Evidence	Direction of effect
ICP	Propofol vs. volatile anesthesia, pooled craniotomy evidence	Favors propofol
Brain swelling	17 RCTs; RR 0.85	Favors propofol overall
Emergency brain swelling	Emergency subgroup	No significant difference
CPP	Propofol generally associated with favorable cerebral physiology	Potential benefit, dependent on MAP
Hypotension	Important adverse physiological consideration with propofol	Requires active management
ICP with ketamine	No consistent clinically important increase	Generally neutral in available evidence
Cerebral perfusion	Dependent on MAP, ICP and $PaCO_2$	Requires individualized control

The physiological results reinforce the concept that ICP not interpreted independently of systemic hemodynamics. A reduction in ICP is potentially beneficial because it may increase CPP, but this relationship depends on preservation of MAP. Consequently, anesthetic-induced hypotension may offset some of the theoretical benefits of an anesthetic that reduces cerebral blood flow or ICP.

The pooled evidence for propofol is nevertheless clinically interesting. The reported mean reduction in ICP was approximately 4 mmHg, while heterogeneity was moderate (I^2=44%). This suggests a relatively consistent direction of effect across the included studies, although the underlying populations were not exclusively patients with emergency intracranial hypertension.

The evidence concerning ketamine is also important because it challenges a long-standing assumption. In the systematic review by Gregers et al. (2020), only two of the evaluated studies reported a small increase in ICP, whereas other studies found either no meaningful difference or reductions in ICP. No evidence of persistent harm attributable to ketamine identified (Figure 3).

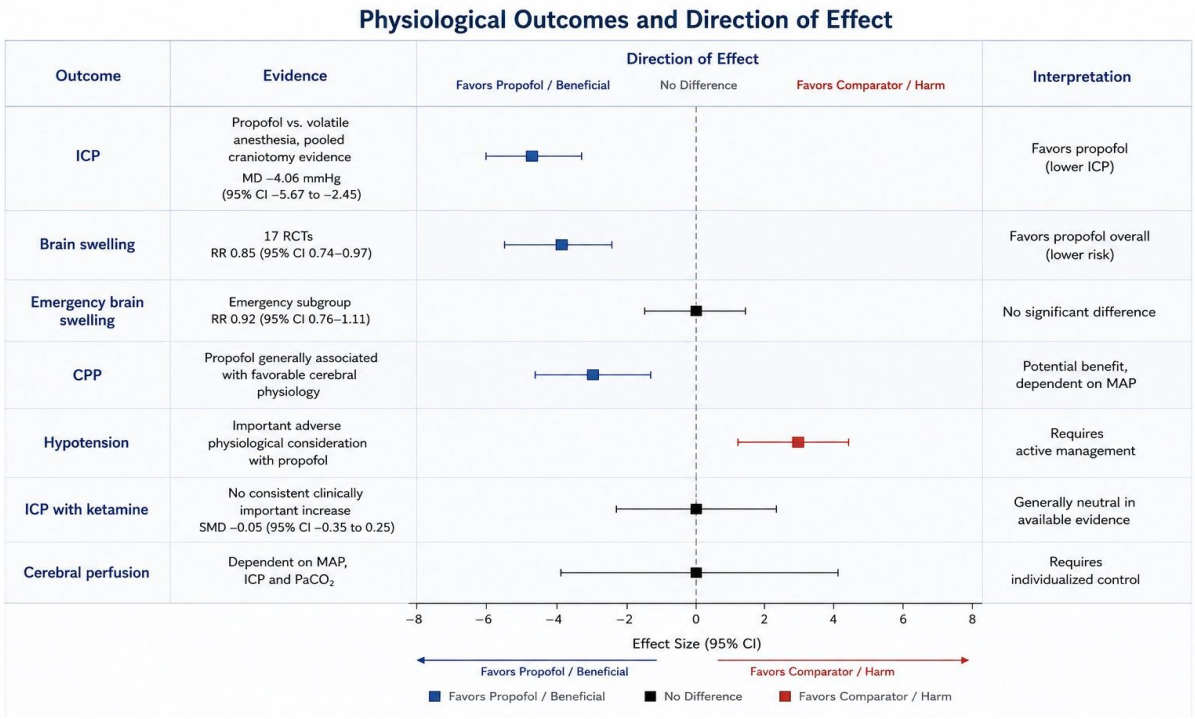

Figure 3. Physiological Outcomes

These findings suggest that contemporary neuro anesthesia should focus less on categorical drug avoidance and more on maintaining adequate cerebral and systemic physiology.

Table 4. Clinical Outcomes and Evidence Limitations

Clinical outcome	Current evidence	Certainty/limitation
Mortality	Limited direct comparative evidence	Insufficient
Neurological outcome	Inconsistently reported	Insufficient
Brain swelling	Better with propofol overall, but not significantly different in emergency subgroup	Moderate heterogeneity
ICP	Lower with propofol in broader craniotomy populations	Applicability to emergencies uncertain
Hemodynamic stability	No consistent overall superiority	Patient-dependent
Recovery/estuation	Variable	Heterogeneous definitions
Emergency neurosurgical outcome	Limited direct evidence	Major evidence gap

Clinical outcomes remain the most important limitation of the current literature. Physiological endpoints such as ICP and brain relaxation are useful surrogate outcomes, but they do not necessarily translate into improved survival or neurological recovery. A patient may have favorable intraoperative ICP control without experiencing meaningful long-term neurological improvement if the underlying brain injury is severe.

The 2023 meta-analysis illustrates this limitation particularly well. Although propofol was associated with lower ICP and reduced overall brain swelling, its subgroup analysis did not demonstrate a significant reduction in brain swelling among emergency craniotomy patients. This suggests that the apparent benefit observed across general craniotomy populations drive partly by elective cases and therefore interpreted cautiously in acute intracranial hypertension. Similarly, the ketamine literature provides reassuring physiological evidence but remains limited in its ability to establish effects on long-term neurological outcomes and mortality. The systematic review included only 11 studies and characterized the overall level of evidence as low. Overall, the evidence supports a physiology-guided approach but does not establish a universally superior anesthetic regimen for emergency neurosurgery (Figure 4).

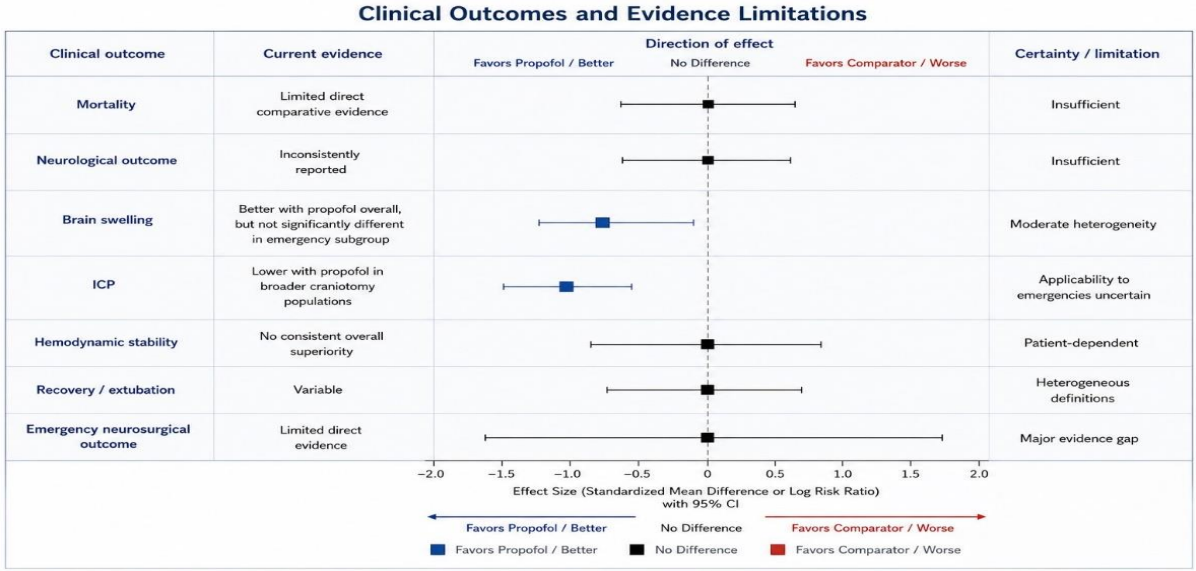

Figure 4. Clinical Outcomes and Evidence Limitations

Overall Synthesis

Taken together, the available evidence indicates that propofol-based anesthesia has favorable effects on ICP and brain relaxation in the broader craniotomy population, while the evidence specifically involving emergency intracranial hypertension remains insufficient to establish superiority. Ketamine appears increasingly acceptable when clinically indicated, particularly when maintenance of hemodynamic stability is important, although definitive evidence regarding long-term outcomes remains limited.

Discussion

The present synthesis indicates that perioperative anesthetic management in emergency neurosurgery for acute intracranial hypertension remains an area characterized by clinically important uncertainty. The available evidence suggests that anesthetic technique can influence cerebral physiology, particularly intracranial pressure (ICP), and cerebral perfusion pressure (CPP), and brain relaxation; however, evidence directly linking a specific anesthetic regimen to improved neurological recovery or survival remains insufficient. The most important finding is therefore not that one anesthetic agent is universally superior, but that successful management depends on maintaining a stable cerebral and systemic physiological environment throughout induction, maintenance, emergence, and the immediate postoperative period [79].

One of the most consistent findings in the broader neurasthenia literature is the favorable effect of propofol on ICP. A meta-analysis of randomized controlled trials demonstrated that propofol-based anesthesia was associated with lower ICP than volatile anesthesia, with a pooled mean difference of approximately −4.06 mmHg. Propofol was also associated with a lower overall risk of brain swelling (Liu et al.,2023). These findings are physiologically plausible because propofol reduces cerebral metabolic rate and cerebral blood flow, thereby potentially decreasing intracranial blood volume and ICP. Earlier evidence similarly suggested improved ICP and CPP profiles with propofol compared with volatile anesthetics [80]. Nevertheless, these findings interpreted cautiously when applied to patients undergoing emergency neurosurgery for acute intracranial hypertension.

The principal reason for caution is the difference between elective and emergency neurosurgical populations. Patients undergoing elective craniotomy generally have greater physiological stability and more predictable intracranial dynamics patients presenting with acute hemorrhage, severe traumatic brain injury, cerebral edema, or impending herniation. In the emergency population, systemic hypotension, hypovolemia, impaired autoregulation, coagulopathy, and severe brain injury may coexist. Under these circumstances, the systemic hemodynamic effects of propofol become particularly important. A substantial reduction in mean arterial pressure may decrease CPP despite a simultaneous reduction in ICP. Thus, an anesthetic that produces a favorable intracranial effect may not necessarily produce a favorable overall cerebral perfusion profile if systemic blood pressure inadequately maintained.

This interaction between ICP and arterial pressure highlights the importance of individualized CPP management. CPP conventionally approximated as MAP minus ICP, meaning that both variables considered simultaneously. In patients with severe acute brain injury, contemporary guidelines emphasize avoidance of hypotension and treatment of elevated ICP when clinically indicated (Carney et al.,2017). Therefore, anesthetic management should not focus exclusively on reducing ICP. Instead, the principal objective should be preservation of adequate cerebral perfusion while preventing

secondary physiological insults such as hypotension, hypoxemia, severe hypocapnia, hypercapnia, and hyperthermia.

The available evidence regarding volatile anesthetics also interpreted within this physiological framework. Volatile agents may produce cerebral vasodilation in a concentration-dependent manner and may consequently increase cerebral blood volume and ICP, particularly at higher concentrations. However, modern ventilation, monitoring, and multimodal neurocritical care may mitigate some of these effects. The available evidence does not demonstrate that volatile anesthesia inevitably produces clinically inferior outcomes in emergency neurosurgery. Rather, the evidence suggests that anesthetic concentration, ventilation, baseline ICP, cerebral autoregulation, and systemic hemodynamics collectively determine the clinical effect [81].

Ketamine represents an especially important development in contemporary neurasthenia. Historically, ketamine frequently avoided in patients with suspected intracranial hypertension because of concerns that its sympathomimetic and cerebral circulatory effects could increase ICP. Recent evidence has challenged this traditional interpretation. Gregers et al. (2020) reviewed 11 studies involving patients with acute brain injury and found no consistent evidence that ketamine produced clinically important increases in ICP. Importantly, the review also failed to demonstrate clear adverse effects on CPP, neurological outcomes, or mortality attributable to ketamine. However, the authors emphasized the low certainty and heterogeneity of the available evidence.

These findings have practical implications for emergency airway management. Patients with severe intracranial pathology may be hypotensive or at risk of becoming hypotensive during induction. In such circumstances, the ability of ketamine to preserve sympathetic tone may be advantageous in selected patients. Nevertheless, ketamine not considered inherently protective of the brain. Its effects remain dependent on the patient's volume status, catecholamine reserve, ventilation, concomitant medications, and underlying pathology. The appropriate interpretation of contemporary evidence is therefore that ketamine no longer categorically excluded solely because of historical concerns regarding ICP [81].

Ventilation represents another critical component of perioperative management. Hypercapnia can increase cerebral blood flow and cerebral blood volume, potentially aggravating ICP, whereas excessive hypocapnia may reduce cerebral blood flow and compromise ischemic brain tissue. Consequently, controlled ventilation should generally aim for physiologically appropriate carbon dioxide levels rather than routine aggressive hyperventilation. The Brain Trauma Foundation guidelines specifically recommend against prophylactic severe hyperventilation in severe traumatic brain injury because of concerns regarding cerebral ischemia. These principles are particularly relevant during emergency neurosurgery because abrupt changes in ventilation frequently occur during induction and transition to mechanical ventilation.

The role of osmotherapy also considered as part of the broader anesthetic strategy. Mannitol and hypertonic saline can reduce cerebral edema and ICP and commonly incorporated into emergency management when clinically indicated. However, their effects on intravascular volume, serum sodium, serum osmolality, renal function, and systemic blood pressure require careful monitoring. The interaction between osmotherapy and anesthetic-induced cardiovascular changes further supports a multidisciplinary approach involving anesthesiology, neurosurgery, and neurocritical care.

A major strength of the current evidence is that it increasingly challenges simplistic assumptions regarding individual anesthetic drugs. The historical view that ketamine should be avoided because it necessarily increases ICP is not strongly supported by contemporary clinical data. Similarly, although propofol demonstrates favorable physiological effects, these effects should not automatically interpret as evidence of improved survival or neurological recovery. This distinction between surrogate physiological outcomes and patient-centered clinical outcomes is essential when interpreting neurasthenia research.

A major limitation, however, is the scarcity of studies specifically examining emergency neurosurgery in patients with acute intracranial hypertension. The recent systematic review by Blacker et al. (2026) identified only nine eligible studies after screening 1,885 abstracts and reviewing 276 full-text articles. All included studies were single-center investigations, and substantial variation existed in interventions and outcome measures. The authors consequently concluded that the available evidence was insufficient for quantitative meta-analysis. This limitation substantially reduces confidence in direct comparisons between anesthetic strategies.

Another limitation is the heterogeneity of underlying neurological conditions. Acute subdural hematoma, intracerebral hemorrhage, traumatic brain injury, cerebral edema, hydrocephalus, and mass lesions can produce intracranial hypertension through different mechanisms. The physiological response to an anesthetic may therefore differ according to pathology, severity, cerebral autoregulation, baseline ICP, and systemic cardiovascular status. Future studies should stratify patients according to the underlying cause of intracranial hypertension rather than treating

emergency neurosurgery as a homogeneous clinical entity.

The available evidence also demonstrates a need for more clinically meaningful outcomes. Future trials should report mortality, functional neurological outcome, duration of mechanical ventilation, ICU length of stay, postoperative complications, and quality of recovery in addition to ICP and CPP. Standardization of definitions for intraoperative hypotension, brain relaxation, ICP control, and neurological outcome would substantially improve the comparability of future studies. From a clinical perspective, the current evidence supports a physiology-guided anesthetic strategy**.** This approach involves careful preoxygenation and airway management, avoidance of prolonged hypotension during induction, appropriate control of ventilation, maintenance of adequate MAP and CPP, avoidance of unnecessary increases in ICP, and individualized selection of anesthetic agents. Propofol may be particularly appropriate in hemodynamically stable patients when reduction of cerebral metabolic activity and ICP is desirable, whereas alternative induction strategies may be preferable in patients at high risk of cardiovascular instability. Ketamine regarded as a potentially acceptable option when clinically indicated rather than automatically excluded because of historical concerns regarding ICP.

Overall, the evidence does not currently support the conclusion that a single anesthetic technique universally recommended for emergency neurosurgery complicated by acute intracranial hypertension. Instead, the available literature supports individualized management based on cerebral physiology, systemic hemodynamics, underlying pathology, severity of neurological injury, and surgical urgency. The most important research priority is therefore not simply another comparison of anesthetic drugs, but well-designed multicenter prospective studies that evaluate anesthetic strategies within standardized perioperative neurocritical-care protocols and measure patient-centered neurological outcomes.

Clinical Implications

The findings have several implications for clinical practice. First, ICP interpreted together with MAP and CPP rather than as an isolated treatment target. Second, prevention of peri-induction hypotension is particularly important in patients with severe intracranial hypertension. Third, contemporary evidence permits greater flexibility in the selection of ketamine when clinically appropriate. Fourth, propofol remains an attractive neurasthenic option because of its favorable effects on cerebral metabolism and ICP, but its cardiovascular effects anticipated and treated promptly. Finally, ventilation, oxygenation, osmotherapy, temperature, analgesia, and postoperative neurocritical care regarded as components of a single integrated strategy rather than independent interventions.

Strengths and Limitations

Strengths:

Several strengths considered when interpreting the findings of this review.

First, the research question addresses a clinically important but relatively under-investigated aspect of neurasthenia: the perioperative management of patients requiring emergency neurosurgery in the setting of acute intracranial hypertension. Unlike broader reviews of neurasthenia, the present framework emphasizes the interaction between anesthetic management, intracranial physiology, systemic hemodynamics, and clinically relevant neurological outcomes.

Second, the review incorporates contemporary evidence concerning both established and evolving anesthetic practices. In particular, the interpretation of ketamine reflects the transition from historical physiological assumptions toward evidence derived from contemporary clinical studies. This is important because anesthetic recommendations based solely on older experimental observations may not adequately reflect current neurocritical-care practice.

Third, the review considers physiological outcomes together with patient-centered outcomes. ICP, CPP, MAP, brain relaxation, and hemodynamic instability are clinically important perioperative variables, but they not interpreted as substitutes for mortality and functional neurological recovery. The distinction between surrogate and patient-centered outcomes strengthens the clinical interpretation of the available evidence.

Fourth, the methodological framework is consistent with contemporary systematic-review reporting principles. PRISMA 2020 provides a 27-item reporting framework and updated flow diagrams intended to improve transparency in the identification, selection, appraisal, and synthesis of evidence.

Limitations

The principal limitation is the scarcity of studies specifically evaluating emergency neurosurgery in patients with acute intracranial hypertension. The most directly relevant systematic review identified only 9 eligible studies from 1,885-screened abstracts and 276 full-text articles. Six studies were prospective and three were retrospective, and all were single-center studies. The investigators concluded that the available evidence was insufficient to conduct a meta-analysis.

A second limitation is substantial clinical heterogeneity. Acute intracranial hypertension may result from traumatic brain injury, intracranial hemorrhage, cerebral edema, hydrocephalus, tumors, or other intracranial processes. These

conditions differ in pathophysiology, cerebral autoregulation, hemodynamic profile, and response to treatment. Pooling all such conditions may therefore produce an apparently precise estimate that does not represent any particular clinical population.

Third, anesthetic interventions frequently delivered as components of multimodal care. For example, a propofol-based technique accompanied by osmotherapy, vasoactive support, and controlled ventilation, corticosteroids in selected pathologies, analgesia, neuromuscular blockade, and surgical decompression. Consequently, isolating the independent contribution of a single anesthetic drug is difficult.

Fourth, outcome definitions are not consistently standardized. Studies may use different thresholds for hypotension, different approaches to measuring ICP, different definitions of brain relaxation, and different instruments or time points for neurological outcome assessment. Such variability reduces the reliability of quantitative comparisons.

Fifth, the evidence concerning long-term outcomes remains particularly limited. Physiological improvement during surgery does not necessarily translate into improved functional neurological recovery. Future studies should therefore prioritize standardized long-term neurological outcomes, in addition to intraoperative physiological endpoints.

Finally, publication bias and selective reporting not excluded. Small single-center studies with positive findings may be more likely to publish than studies showing no difference between anesthetic techniques. This possibility is particularly relevant in a field in which the number of eligible studies is small and formal assessment of publication bias may have limited statistical power.

Recommendations for Future Research

Future research should focus on multicenter prospective investigations comparing standardized perioperative anesthetic strategies in well-defined emergency neurosurgical populations. Studies should stratify patients according to the cause and severity of intracranial hypertension and should report baseline ICP, CPP, neurological status, systemic hemodynamics, and relevant comorbidities.

Randomized trials comparing intravenous and volatile anesthetic strategies should incorporate both physiological and patient-centered endpoints. Primary outcomes could include neurological functional outcome and mortality, whereas secondary outcomes could include ICP burden, CPP, intraoperative hypotension, vasopressor requirements, postoperative ventilation, ICU length of stay, and complications.

Future investigations should also evaluate ketamine in appropriately selected patients rather than excluding it solely based on historical concerns regarding ICP. Contemporary evidence suggests that these concerns may not be universally applicable, but higher-quality comparative evidence is required before definitive recommendations made.

Standardized definitions are equally important. Researchers should establish consistent definitions for intraoperative hypotension, intracranial hypertension, brain relaxation, neurological deterioration, and favorable functional outcome. Consistent reporting would make future evidence more suitable for quantitative synthesis.

Finally, future systematic reviews should prospectively register their protocols, follow PRISMA 2020 reporting standards, and clearly distinguish between direct evidence from emergency neurosurgical populations and indirect evidence derived from elective craniotomy or broader acute brain-injury populations

Conclusion

Acute intracranial hypertension requiring emergency neurosurgical intervention represents one of the most challenging situations in contemporary neurasthenia. The combination of critically elevated intracranial pressure, impaired intracranial compliance, potentially compromised cerebral autoregulation, systemic instability, and the urgent need for surgical treatment creates a narrow physiological margin for error. The findings synthesized in this review indicate that perioperative anesthetic management has an important role in maintaining cerebral and systemic homeostasis, but current evidence does not support the universal superiority of a single anesthetic technique.

Among the available strategies, propofol-based anesthesia has demonstrated relatively consistent physiological advantages in broader craniotomy populations. Randomized evidence suggests that propofol can reduce ICP and may improve brain relaxation compared with volatile anesthetic techniques. These effects are physiologically plausible because propofol decreases cerebral metabolic activity and cerebral blood flow. However, the clinical significance of these advantages in emergency neurosurgery remains uncertain. Importantly, the evidence from elective or mixed craniotomy populations not automatically extrapolated to patients with acute intracranial hypertension, severe traumatic brain injury, intracranial hemorrhage, or impending herniation.

The potential benefit of propofol also balanced against its cardiovascular effects. Hypotension during induction or maintenance of anesthesia can reduce cerebral perfusion, particularly when ICP is already elevated. Therefore, reducing ICP without preserving systemic arterial pressure may not produce the desired improvement in cerebral perfusion. Anesthetic management should consequently prioritize the relationship between

ICP, MAP, and CPP rather than focusing on a single physiological variable.

Contemporary evidence concerning ketamine is particularly relevant to emergency neurasthenia. Earlier recommendations to avoid ketamine in patients with intracranial hypertension largely based on older physiological studies. Recent clinical evidence has not demonstrated a consistent clinically significant increase in ICP attributable to ketamine. Although the certainty of evidence remains limited, these findings suggest that ketamine not categorically excluded when its pharmacological properties are otherwise advantageous. Its potential hemodynamic benefits may be particularly relevant in selected patients who are vulnerable to induction-related hypotension.

The available literature also reinforces the importance of non-pharmacological components of neurasthenic management. Adequate oxygenation, controlled ventilation, avoidance of severe abnormalities in arterial carbon dioxide tension, maintenance of appropriate blood pressure, timely treatment of elevated ICP, and prevention of secondary physiological insults are fundamental elements of perioperative care. These measures may influence neurological outcomes as substantially as the choice between individual anesthetic agents.

A major conclusion of this review is that the current evidence base remains insufficient for establishing a universally optimal anesthetic regimen specifically for emergency neurosurgery in acute intracranial hypertension. The recent systematic review focused specifically on emergent or urgent craniotomy and craniectomy identified only nine eligible studies and found substantial heterogeneity among them. The predominance of single-center studies, variation in patient populations and interventions, and inconsistent reporting of outcomes limit the strength and generalizability of available conclusions.

Future research should therefore move beyond comparisons of isolated anesthetic drugs. Multicenter randomized or carefully designed prospective studies should investigate standardized perioperative strategies and report clinically meaningful outcomes, including mortality, long-term functional neurological recovery, and duration of mechanical ventilation, ICU length of stay, postoperative complications, and quality of neurological recovery. Studies should also stratify patients according to the underlying cause of intracranial hypertension, because the physiological characteristics of traumatic brain injury, intracranial hemorrhage, cerebral edema, hydrocephalus, and intracranial mass lesions are not identical.

In conclusion, the current evidence favors an individualized, physiology-guided approach to perioperative neurasthenia. Propofol remains a valuable option because of its favorable effects on cerebral physiology, whereas ketamine appears to be a reasonable alternative in appropriately selected patients and not rejected solely because of historical concerns about ICP. Nevertheless, preservation of CPP, prevention of hypotension and hypoxemia, appropriate ventilation, timely control of ICP, and close coordination between anesthesiology, neurosurgery, and neurocritical-care teams are likely to be more important than reliance on any single anesthetic drug.

Ultimately, successful perioperative management of acute intracranial hypertension understood as an integrated strategy aimed at preventing secondary brain injury while facilitating urgent surgical treatment. Until stronger comparative evidence becomes available, clinical decisions individualized according to the patient's neurological status, ICP, CPP, cardiovascular condition, underlying pathology, surgical urgency, and response to therapy. This approach provides the most defensible interpretation of the current literature while highlighting the need for high-quality prospective research.

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Conflicts of interest

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References

[1] Hosseinpoor, S., & Yousef, R. M. (**2027**). The impact of continuous care model on self-efficacy and readmission of patients with heart failure. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, 6(1), 1–14.

[2] Hosseinpoor, S., & Yousef, R. M. (**2026**). Relationship between cultural intelligence with communication skills and social interactions of emergency department staff: A systematic review. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, 5(4), 289–301.

[3] Hosseinpoor, S., & Yousef, R. M. (**2026**). Cardiopulmonary-cerebral resuscitation (CPCR)

training for nurses in Iran: A systematic review study. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, 5(4), 302–313.

[4] Yousef, R. M., Abdulsahib, A. J., Ramezani, R., Shamsi, A., & Shahidi Delshad, E. (**n.d**.). Ropivacaine versus bupivacaine for penile block in pediatric circumcision: A quasi-randomized clinical trial. *Archives of Anesthesiology and Critical Care.*

[5] Mohamadi Moghadam, A. (**2025**). Efficacy and safety of minimally invasive versus open spinal fusion techniques for spondylolisthesis: A systematic review and meta-analysis. *Medicinal, Psychological, and Health Research Journal*, 1(11), 370–377.

[6] Mohamadi Moghadam, A. (**2025**). Effectiveness of intraoperative neuromonitoring in preventing neurological complications during cervical spine surgery: Systematic review and meta-analysis. *Medicinal, Psychological, and Health Research Journal*, 1(11), 378–386.

[7] Hashemloo, A., & Milanifard, M. (**2026**). Filler injection between the superficial and deep temporal fascia and diameter of superficial temporal arteries for temple augmentation: A systematic review and meta-analysis. *Journal of Cosmetic Dermatology*, 25(1), e70632.

[8] Milanifard, M., & Hashemloo, A. (**2026**). Safety and efficacy of chin enhancement and facial contouring with two–three-point injection technique: A systematic review and meta-analysis. *Aesthetic Plastic Surgery*, 50, 3060–3067.

[9] Hashemloo, A., & Milanifard, M. (**2026**). Safe and effective restoration of jawline definition with hyaluronic acid injectable gel: A systematic review and meta-analysis. *Acta Dermatovenerologica Alpina, Pannonica et Adriatica*, 35(2), 93–98.

[10] Hashemloo, A., & Milanifard, M. (**2026**). Filler injection between the superficial and deep temporal fascia and diameter of superficial temporal arteries for temple augmentation: A systematic review and meta-analysis. *Journal of Cosmetic Dermatology*, 25(1), e70632.

[11] Milanifard, M., & Hashemloo, A. (**2026**). Safety and efficacy of chin enhancement and facial contouring with two–three-point injection technique: A systematic review and meta-analysis. *Aesthetic Plastic Surgery*, 50, 3060–3067.

[12] Hashemloo, A., & Milanifard, M. (**2026**). Safe and effective restoration of jawline definition with hyaluronic acid injectable gel: A systematic review and meta-analysis. *Acta Dermatovenerologica Alpina, Pannonica et Adriatica*, 35(2), 93–98.

[13] Hashemloo, A., & Milanifard, M. (**2025**). Cerebral embolism as a result of facial filler injections: A literature review. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*,. 5(1), 8-16.

[14] Hashemloo, A., & Milanifard, M. (**2025**). Treatment algorithm of complications after filler injection: Based on wound healing process. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*. 5(1), 1-7.

[15] Rahi, D., Ghotbi, N., Nosratabadi, R., Sayyari, M., & Sabzevari, B. (**2023**). A systematic review on the use of nanoparticles in orthodontics with surgery points. *The Seybold Report*, 18(6), 1542–1559.

[16] Janeshi, A., Mahjoub, P., Soltani, H., Rahi, D., & Maleki, D. (**2023**). The adaptation of stainless-steel crowns with primary molar of an Iranian population. EC Dental Science, 22(5), 75–83.

[17] Rahi, D., Abbassi, S., & Tajbakhsh, N. (2024). Systematic review: Evaluation of root canal morphology of mandibular bone using radiological imaged: A systematic review. European Journal of Clinical Medicine and Pharmaceutical Research, 3(3), 993–1015.

[18] Dehrouye-Semnani, F., Charkari, N. M., & Mirbagheri, S. M. M. (**2021**). Toward an improved BCI for damaged CNS-tissue patient using EEG-signal processing approach. *arXiv*.

[19] Rezai, M., Amiri, H., Delbari, D., Keshmiri, Y. S., Aghdam, H., Zohri, D., & Hesam, R. (**2019**). Comparison of intramuscular injection of ketorolac and conventional treatment in the field of cost-effectiveness, length of stay and pain relief in patients admitted to the emergency department with renal colic. *Bali Medical Journal*, 8(1), 83–87.

[20] fard,M M , Kasnavieh,S M H , Hessam,R , Ghoddusi,M and Shokri,A . (**2025**). Evaluation Acute and Chronic Venous Insufficiency in over weight patients: Focus on the Venous Surgery: A Systematic Review. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *1*(12), 405-414.

[21] Hosseini Kasnavieh, S. M., Shaker, S. H., Milanifard, M., Hessam, R., & Ghadesi, M. (**2026**). Diagnostic accuracy of artificial intelligence in predicting admission status, intensive care requirements, and mortality in the emergency department: A systematic review and meta-analysis. *Medical Journal of the Islamic Republic of Iran.*

[22] Rezai, M., Javdani Esfehani, K., Valipour, A. M., Hessam, R., Soleymani, N., Zarei Jelyani, N., & Javan, A. (**2026**). Comparative survival and mortality outcomes of severely injured patients

transferred via air ambulance versus ground ambulance in pre-hospital emergency settings. *European Journal of Scientific Research and Reviews*, 4(1), 95–111.

[23] Hessam, R., Rezvani, A., Shaker, S. H., Mosaddegh, R., & Milanifard, M. (**2025**). Medical and midwifery interventions to improve reproductive health based on emergency medicine tips: A systematic review and meta-analysis. *Journal of Chemical Biological and Physical Sciences*, 13(4), 1108–1135.

[24] Rezai, M., Khodamorad, A., Valipour, A. M., Hessam, R., Mohammadi, M., Javdani Esfahani, K., & Kheradpishe, A. (**2025**). Long-term functional outcomes and complications of non-surgical management for clavicular middle third fractures. *Journal of Orthopedic and Spine Trauma,* 11(2), 61–63.

[25] Javdani Esfehani, K., Ghafoury, R., Hosseini, S. M., Hessam, R., Mohammadi, M., Hamidi, R., & Gholami Gharab, S. (**2025**). Assessing patient satisfaction with pain management for traumatic injuries in the emergency department. *Rawal Medical Journal*, 50(2), 501–505.

[26] Asna Aashari, M., Aghazadeh, P., Javdani Esfehani, K., Hessam, R., Rezai, M., Tabibzadeh Dezfooli, S., & Javan, A. (**2024**). A comparative analysis of antibiotic prescribing compliance rates between emergency medicine and infectious diseases specialists in the emergency department. *Avicenna Journal of Clinical Microbiology and Infection*, 11(4), 177–181.

[27] Mosaddegh, R., Mirzapoor, G., Mohammadi, M., …, Hessam, R., …, & Zarrin, A. (**2024**). Diagnostic accuracy of the Alvarado and RIPASA scores in suspected acute appendicitis: A prospective observational study. *Journal of Payavand Medical Education.*

[28] Farsi, D., Zohri, D., Abbasi, S., Hessam, R., Navkhasi, S., & Saifpanahi, J. (**2019**). Comparison of the diagnostic values of four-point and two-point ultrasound versus CT scan in determining pneumothorax. *Pajouhan Scientific Journal*, 17(4), 9–14.

[29] Moghadam, A M. (**2025**). Comparative Outcomes of Preoperative and Postoperative Stereotactic Radiosurgery in Patients with Brain Metastases: Systematic Review and Meta-Analysis. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *1*(11), 392-402.

[30] Moghadam, A M. (**2025**). Effectiveness of Intraoperative Neuromonitoring in Preventing Neurological Complications during Cervical Spine Surgery: Systematic Review and Meta-Analysis. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *1*(11), 378-386.

[31] Moghadam, A M. (**2025**). Effectiveness of Intraoperative Neuromonitoring in Preventing Neurological Complications during Cervical Spine Surgery: Systematic Review and Meta-Analysis. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *1*(11), 403-411.

[32] Moghadam, A M. (**2025**). Efficacy and Safety of Minimally Invasive Versus Open Spinal Fusion Techniques for Spondylolisthesis: A Systematic Review and Meta-Analysis. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *1*(11), 370-377.

[33] Moghadam, A M. (**2026**). Comparative Outcomes of Preoperative and Postoperative Stereotactic Radiosurgery in Patients Undergoing Resection for Brain Metastases: Systematic Review and Meta-Analysis. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(2), 137-146.

[34] Moghadam, A M. (**2026**). Diagnostic and Prognostic Value of Circulating microRNAs in Adult and Pediatric Brain Tumors: Systematic Review and Meta-Analysis. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(3), 156-167.

[35] Moghadam, A M. (**2026**). Diagnostic and Prognostic Value of Circulating microRNAs in Adult Brain Tumors: Systematic Review and Meta-Analysis. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *2*(1), 42-49.

[36] Moghadam, A M. (**2026**). Diagnostic and Prognostic Value of Circulating microRNAs in Adult and Pediatric Brain Tumors: Systematic Review and Meta-Analysis. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(3), 156-167.

[37] Moghadam, A M. (**2026**). Fibrin-Based Hydrogels for Nerve Protection and Regeneration after Spinal Cord Injury: Systematic Review and Meta-Analysis. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(2), 106-116.

[38] Moghadam, A M. (**2026**). Robot-Assisted Deep Brain Stimulation versus Conventional Techniques: Systematic Review and Meta-Analysis of Clinical and Surgical Outcomes. *Medicinal,*

Psychological, and Health Research Journal (MPHRJ), 2(2), 147-155.

[39] Hosseini Kasnavieh SM, Milanifard M, Sedighi M, Hessam R. (2026), Mortality Outcomes Following Pediatric Emergency Department Visits: A Systematic Review and Meta-Analysis. *Med J Islam Repub Iran*. 40:61.

[40] Hosseini Kasnavieh SM, Milanifard M, Sedighi M, Hessam R. (**2026**), A Systematic Review of Pain Assessment Tools in Prehospital Emergency Care: Evidence from Observational Studies. Med J Islam Repub Iran. 40:60.

[41] Hessam R, Basir Ghafouri H, Rezai M, Shaker S H, Hosseini Kasnavieh S M, Milanifard M et al . (**2026**), Hidden and Atypical Presentations of Myocarditis in Sudden Cardiac Death: A Narrative Review. Med J Islam Repub Iran; 40 (1) :526-536

[42] Mousaei Nejad, N., Aarabi, S., Zangi, M., Mohammadi, M., & Naderkhani, M. (2025). Emergency medicine board book *2025*.

[43] Sajed M, Alvandifar S, Mallahi M. (**2024**), Evaluation of Root Canal Morphology of Mandibular Premolars Using Cone-beam Computed Tomography in Golestan Province, North of Iran. Iran Endod J. 2024;19(3):183-188. PMID: 39086715; PMCID: PMC11287047.

[44] Dehrouye-Semnani, F., charkari, N.M., & Mirbagheri,S.M.M.(**2021**).Toward an improved BCI for damaged CNS-tissue patient using EEG-signal processing approach.arXiv.

[45] S Shaghaghi, JK Udupa, Y Tong, Y Akhtar, M Hosseini, M Al-Noury, C Wu, L Xie, Y Hao, S Hassani, S Gogel, DM Biko, OH Mayer, JM McDonough, PJ Cahill, JB Anari, (**2025**), DA Torigian. Association between respiratory volumes estimated from free-breathing dynamic MRI and sagittal spinal curvature in pediatric patients with thoracic insufficiency syndrome. Medical Imaging 2025: *Image-Guided Procedures, Robotic Interventions, and Modeling*. Proceedings Volume 13408,

[46] Mahsa Afrand. (**2024**), Systematic review: Systematic review of neurological problems and stress in Alzheimer's patients with drug tips. *Eurasian journal of Chemical, Medicinal and Petroleum Research*, 3(5): 114-128.

[47] Motaqi,M.,Ghanjal,A.,& Afrand,M.(**2022**).Treadmill exercise and its effect on rehabilitation of patients after ischemic stroke:A narrative study. *International Journal of Musculoskeletal pain prevention*,7(3),730-740.

[48] Motaqi,M.,Afrand,M.,& Ghanjal,A. (**2022**). Care and management of pain in patients with musculoskeletal pain during the COVID-19 epidemic. *International Journal of Musculoskeletal pain prevention*,7(1),622-626.

[49] Motaqi,M.,Samadi ,M.,& Ghanjal,A., & Afrand,M (**2022**).A new approach to evaluate musculoskeletal pain Prevention ,7(4),781-787.

[50] Ahmady,H.,Afrand,M.,Motaqi,M.,& Meftahi,G.H.(**2024**).Utilizing Sertoli cell transplantation as a therapeutic technique for the management of neurodegenerative diseases. *Archives of Razi Institute*, 79(4),701-710.

[51] Afrand,M.,Rostampur,N.,Pourhadi,z.,Rezane zhad,J.,&Nekoueifard,P.(**2025**).Epilepsy in children with central nervous system infections:A systematic review and meta-analysis. *AFMN Biomedicine*, 42(4),450-455.

[52] Ahmady, H., Afrand, M., Motaqi, M., & Meftahi, G. H. (**2024**). Utilizing Sertoli cell transplantation as a therapeutic technique for the management of neurodegenerative diseases. *Archives of Razi Institute*, 79(4), 701–710.

[53] Motaqi, M., Afrand, M., & Ghanjal, A. (**2022**). Care and management of pain in patients with musculoskeletal pain during the COVID-19 epidemic. *International Journal of Musculoskeletal Pain Prevention*, 7(1), 622–626.

[54] Motaqi, M., Ghanjal, A., & Afrand, M. (**2022**). Treadmill exercise and its effect on rehabilitation of patients after ischemic stroke: A narrative study. *International Journal of Musculoskeletal Pain Prevention*, 7(3), 730–740.

[55] Motaqi, M., Samadi, M., Ghanjal, A., & Afrand, M. (**2022**). A new approach to evaluate of musculoskeletal pain. *International Journal of Musculoskeletal Pain Prevention*, 7(4), 781–787.

[56] Afrand, M., Rostampur, N., Pourhadi, Z., Rezanezhad, J., & Nekoueifard, P. (**2025**). Epilepsy in children with central nervous system infections: A systematic review and meta-analysis. *AFMN Biomedicine*, 42(4), 450–455.

[57] Ahmady, H., Afrand, M., Motaqi, M., & Meftahi, G. H. (**2024**). Utilizing Sertoli cell transplantation as a therapeutic technique for the management of neurodegenerative diseases. *Archives of Razi Institute*, 79(4), 701–710.

[58] Motaqi, M., Afrand, M., & Ghanjal, A. (**2022**). Care and management of pain in patients with musculoskeletal pain during the COVID-19 epidemic. *International Journal of Musculoskeletal Pain Prevention*, 7(1), 622–626.

[59] Motaqi, M., Ghanjal, A., & Afrand, M. (**2022**). Treadmill exercise and its effect on rehabilitation of patients after ischemic stroke: A narrative study. *International Journal of Musculoskeletal Pain Prevention*, 7(3), 730–740.

[60] Motaqi, M., Samadi, M., Ghanjal, A., & Afrand, M. (**2022**). A new approach to evaluate of musculoskeletal pain. *International Journal of Musculoskeletal Pain Prevention*, 7(4), 781–787.

[61] Afrand, M., Rostampur, N., Pourhadi, Z., Rezanezhad, J., & Nekoueifard, P. (**2025**). Epilepsy in children with central nervous system infections: A systematic review and meta-analysis. AFMN Biomedicine, 42(4), 450–455.

[62] Samimi,A . (**2025**). Assessment of Risks Arising from Neuropsychological Crises in Cardiac Patients Using FMEA. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *1*(7), 196-203.

[63] Samimi,A . (**2025**). Risk Assessment in Hospitals Using the FMEA Method: A Data-Driven Analysis for Patient Safety Improvement. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *1*(6), 180-187.

[64] Samimi,A . (**2025**). Application of Failure Mode and Effects Analysis (FMEA) for Risk Management in Hospital Laboratories. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *1*(5), 160-168.

[65] Seyed Hoseini,S V and Nasseri,A R . (**2026**). Identification of Predictive Factors for Late Radiotherapy Induced Complications in Post Mastectomy Breast Cancer Survivors. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(6), 409-418.

[66] Seyed Hoseini,S V and Nasseri,A R . (**2026**). Clinical Significance of Preoperative Serum Albumin Levels in Predicting Survival After Surgery in Patients Undergoing Colorectal Cancer Resection. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(6), 419-428.

[67] Güngör,S . (**2026**). The Efficacy of Cognitive Behavioral Therapy (CBT) in Treating Treatment-Resistant Depression: Mechanisms and Long-Term Outcomes. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(6), 438-451.

[68] Mokabber,N , Mokaber,M and Lotfi,A R . (**2026**). Effects of Dexmedetomidine on the Incidence of Agitation and Pain Severity after Traumatic Nasal Surgeries. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(6), 452-460.

[69] Hessam,R and Milanifard,M . (**2026**). Clinical Performance of Wearable and Continuous Vital Sign Monitoring Technologies in Emergency Department Patients: A Systematic Review and Meta-analysis. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(6), 461-471.

[70] Aghili,A and Najafi,S . (**2026**). Effectiveness of Antibiotic Prophylaxis in Preventing Postoperative Infection Following Total Knee Arthroplasty: A Systematic Review. *Medicinal, Psychological, and Health Research Journal (MPHRJ)*, *2*(6), 429-437.

[71] Lotfi, A R and Nouri Bayat, L. (**2026**). Incidence of Postoperative Complications Following Nasal Fracture Surgery in Adults. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *2*(2), 175-182.

[72] Rahmani, A and Abadi, P M S. (**2026**). Effectiveness of Skin Graft Fixation Techniques in Plastic Surgery: A Systematic Review and Meta-Analysis. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *2*(4), 309-325.

[73] salehitali, S , Hassanpour, A and Rahimi, K. (**2026**). The effectiveness of educational interventions based on the collaborative care model on treatment adherence in patients with chronic kidney failure undergoing hemodialysis: A clinical trial study. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *2*(4), 326-331.

[74] Rahmani, A and Abadi, P M S. (**2026**). Efficacy of Negative Pressure Wound Therapy Compared to Conventional Wound Closure in Plastic and Reconstructive Surgery: A Systematic Review and Meta-Analysis. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *2*(4), 383-396.

[75] Afaharipoor, N , Rafsanjani, M N N and Otaghvar, H A. (**2026**). A multidisciplinary approach to axillary management in early-stage breast cancer: a systematic and meta-analysis. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research (JAMPBR)*, *2*(4), 397-408.

[76] Abdoos, P. (**2025**). Emerging Infectious Diseases: Strategies for Prevention and Control. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, *4*(1), 88-104.

[77] Kumar BS,A , Narayan BA,D , S,M , D,D and N,D . (**2025**). Emerging Targeted Therapies in

Asthma: Biologics, Small Molecules, and Innovative Inhaled Formulations. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, *4*(1), 105-115.

[78] Saffarijourshari, M and Zolala, E. (**2025**). Sports Musculoskeletal Injury in the Professional Athlete with Clinical and Rehabilitation Point. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, *4*(1), 116-128.

[79] Salek Shahabi, M. (**2026**). Artificial Intelligence for Early Detection and Diagnosis of Breast Cancer: A Systematic Review of Machine Learning and Deep Learning Approaches. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, *5*(1), 64-76.

[80] Horestani, M K. (**2026**). Microbiome Dysbiosis as a Predictor of Gastrointestinal Disorders and Metabolic Diseases. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, *5*(2), 101-113.

[81] Aghahosseini, S S and Erfani, S. (**2025**). Evaluate the effect of mindfulness interventions on psychological detachment from work: A systematic review and meta-analysis of randomized controlled trials. *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, *4*(2), 198-206.