

# Perioperative Cognitive Dysfunction: Comparative Evaluation of Anesthetic Agents and Neurocognitive Outcomes in Elderly Patients: A Systematic Review and Meta-Analysis

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## ABSTRACT

**Background:** The occurrence of perioperative cognitive dysfunction (POCD) affects many elderly surgical patients in their postoperative period, notwithstanding worries about enduring issues caused by distinct anesthetic methods. This systematic review and meta-analysis aimed to assess the effects of the various types of anesthesia agents and procedures on postoperative cognitive dysfunction among adult surgical patients.

**Methods:** This systematic review and meta-analysis follow PRISMA 2020 guidelines. The following randomized and observational studies assessing postoperative cognitive outcomes were searched in PubMed, Scopus, Web of Science, and Google Scholar up to May 2025. To determine risk of bias, the Cochrane Risk of Bias Tool on RCTs and the Newcastle-Ottawa Scale (NOS) on observational studies were used. The degree of confidence of the included outcomes was measured with the GRADE framework. The meta-analysis was conducted using RevMan 5.4.1, and heterogeneity (I<sup>2</sup>) was also assessed.

**Results:** Ten studies, including 1,170 participants, have been analyzed, and the majority of comparisons made are the effect of anesthetic agents on postoperative cognitive dysfunction (POCD). Other agents, such as remimazolam, scopolamine, and S-ketamine, produced better cognitive results as compared to others that did not produce significant results. Cognitive scores were found not to be statistically different between treatments (SMD: -0.57, 95% CI: -1.51 to 0.36) and had a high heterogeneity (I<sup>2</sup> = 94%).

**Discussion:** Some of these anesthetic agents, like remimazolam, S-ketamine, and scopolamine, have promising results in the prevention of early postoperative cognitive dysfunction, but the overall evidence is at the same time inconsistent. Meta-analysis failed to execute expressions of meaningful cognitive effects throughout habitations, stressing the importance of standard cognitive evaluations and future high-quality tests. There is a tendency towards high levels of heterogeneity and variability in cognitive outcome measures, and hence, the limited generalizability.

**Keywords:** Postoperative Cognitive Complications, Anesthesia, General, Cognition Disorders, Neuropsychological Tests, Randomized Controlled Trials.

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## INTRODUCTION

Elderly patients experience Perioperative cognitive dysfunction (POCD) as a surgical complication along with the increased susceptibility of their age-related neurological condition<sup>1</sup>. It heightens the susceptibility to cognitive diminishment after anesthesia and surgical procedures<sup>2</sup>. It is a common complication among elderly surgical patients, largely attributed to their heightened vulnerability stemming from age-related neurodegenerative changes and reduced cognitive reserve, which exacerbate the impact of anesthesia and surgical stress on brain function<sup>3</sup>.

POCD leads to persistent memory and attention, and executive function deficits that last multiple weeks or months and negatively impact the recovery process, leading to decreased independence and reduced long-term quality of life<sup>4</sup>. Its incidence and severity are significantly influenced by the choice of anesthetic agents, which play a critical role in determining neurocognitive outcomes in elderly surgical patients<sup>5</sup>. Therefore, the selection of anesthesia agents stands as a primary factor that determines the neurocognitive results among elderly patients<sup>6</sup>.

Each neurochemical pathway of inhalational and intravenous anesthetics affects the central nervous system by using specific mechanisms<sup>7</sup>. The predictable pharmacokinetics of sevoflurane and isoflurane make these agents popular, but they increase neuroinflammation and potentially cause neurotoxicity in patients<sup>8</sup>.

The use of total intravenous anesthesia (TIVA) with propofol reduces oxidative stress and regulatory capabilities within neuroinflammatory pathways, exhibiting both neuroprotective effects<sup>9</sup>. The different medications impact the rate of POCD development, together with its magnitude and

repetition duration, differently, depending on their pharmacologic mechanisms, neuroinflammatory effects, and interaction with patient-specific vulnerabilities such as age or comorbidities<sup>10</sup>.

The wide range of clinical results that depend on anesthetic type, alongside individual patient conditions and surgical procedures, creates obstacles to creating uniform perioperative procedures. Research-based guidelines face impediments because of the contradictory results between different clinical studies<sup>11</sup>. The medical professionals need to conduct extensive examinations immediately to better understand the link between anesthetic medicines and cognitive effects in elderly surgical patients.

The systematic review and meta-analysis aimed to determine the effects of the various types of anesthesia agents and procedures on postoperative cognitive dysfunction among adult surgical patients. It studied cognitive outcomes (including Mini-Mental State Examination (MMSE) scores, Montreal Cognitive Assessment (MoCA) and POCD incidence) among interventions.

## METHODS

### PRISMA Guideline

This systematic review and meta-analysis adhered to the PRISMA 2020 guidelines<sup>12</sup>. To ensure high-quality research, the search was carried out in four databases, including PubMed, Scopus, Web of Science, and Google Scholar, to find available articles until May 2025. English-language studies were only considered, and the studies had to be human. Combinations of keywords and Boolean operators that were employed in the search strategy included postoperative cognitive dysfunction, POCD, cognitive impairment, standardized scores, anesthesia, general

anesthesia, spinal anesthesia, S-ketamine, minocycline, propofol, sevoflurane, elderly surgery patients, as well as neurocognitive outcome. Results were filtered by applying the filters of clinical trials and observational studies.

#### **Inclusion and Exclusion Criteria**

The inclusion criteria were the following: randomized controlled trials (RCTs), prospective or retrospective observational studies, case-control or comparative cross-sectional studies targeting cognitive outcomes following surgery with the involvement of standardized assessment tools. The requirement was quantitative data (mean + or - SD or extractable statistics) of the post-operational cognitive performance. Exclusion criteria were non-English, animal/ in vitro studies, editorials, reviews, case reports, or non-comparator analyses of control vs. intervention or lack of extractable quantitative data of cognitive outcome data.

#### **Primary And Secondary Outcomes**

The primary outcomes were the variation in the cognitive scores at the time before and after the surgery based on interventions (e.g., type of anesthetic or neuroprotective agents) and the incidence of POCD. The secondary outcome measures were measures of multiple postoperative times, postoperative delirium, and biomarkers in serum (e.g., S100B, IL-6, TNF-alpha) in case of a report. Where possible, subgroups of anesthesia (general vs spinal vs combined), pharmacologic interventions (back to example in first sentence), and type of surgery were used. There was a three-tier screening, which entailed title, abstract, and full-text meetings of two independent reviewers. There were many disagreements, and they were solved by discussion or a third reviewer. Automation tools have not been applied.

#### **Study Selection and Tools**

Independent extraction was performed using a standardized extraction form that contained: author, year, study design, sample size, intervention/control groups, cognitive assessment tools, timing of evaluations, and results (mean +/- SD or incidence rates with ORs or SMDs). Where needed, data was lacking, and authors were contacted. The Cochrane Risk of Bias Tool was used to evaluate the risk of bias of research conducted in

the form of RCTs, whereas the Newcastle-Ottawa Scale (NOS) was used to evaluate the risk of bias of observational and case-control studies. The GRADE framework was used in determining the certainty of evidence of each outcome. Ten studies were identified as inclusion criteria: 9 RCTs and 1 observational study, and the subject of comparison was the anesthesia type, pharmacological intervention, and postoperative neurocognitive performance<sup>13,14,15,16,17,18,19,20,21,22</sup>.

#### **Meta Analysis**

Meta-analyses were done by RevMan version 5.4.1. In case of continuous outcome (cognitive scores), standardized mean difference (SMD) and 95% confidence intervals (CI) were determined through the inverse variance method and random-effects model. In the case of a dichotomous outcome (e.g., incidence of POCD), odds ratios (ORs) were calculated with 95% CI. The I<sup>2</sup> statistic was used to measure heterogeneity, with I<sup>2</sup> greater than 50 percent being moderate to high. Narrative synthesis has been given where there was a significant degree of heterogeneity (I<sup>2</sup> > 75%). Subgroup analyses were made according to intervention type, cognitive domain tested, and postoperative assessment time. The sensitivity analyses were used to assess the stability of the effects estimate by omitting high-risk studies. Visual presentation of results was done in the form of forest plots, and thorough summary tables described the characteristics of the studies included, their results, and bias evaluation. The descriptive synthesis of studies unfit for meta-analysis was performed.

#### **RESULTS**

Among 114 screened records, 10 studies were found to meet the inclusion criteria: 9 randomized controlled trials and 1 observational study, with various anesthesia interventions and cognitive tests. Studies were excluded primarily due to being review articles, case reports, animal or in vitro experiments, lacking quantitative cognitive data, non-comparative in design, or not assessing POCD as an outcome. The majority of studies assessed the effects of such agents as sevoflurane, propofol, remimazolam, esketamine, and S-ketamine on postoperative cognitive dysfunction (POCD) with the help of MMSE or some other cognitive test. The study selection is summarized in **Figure 1**.

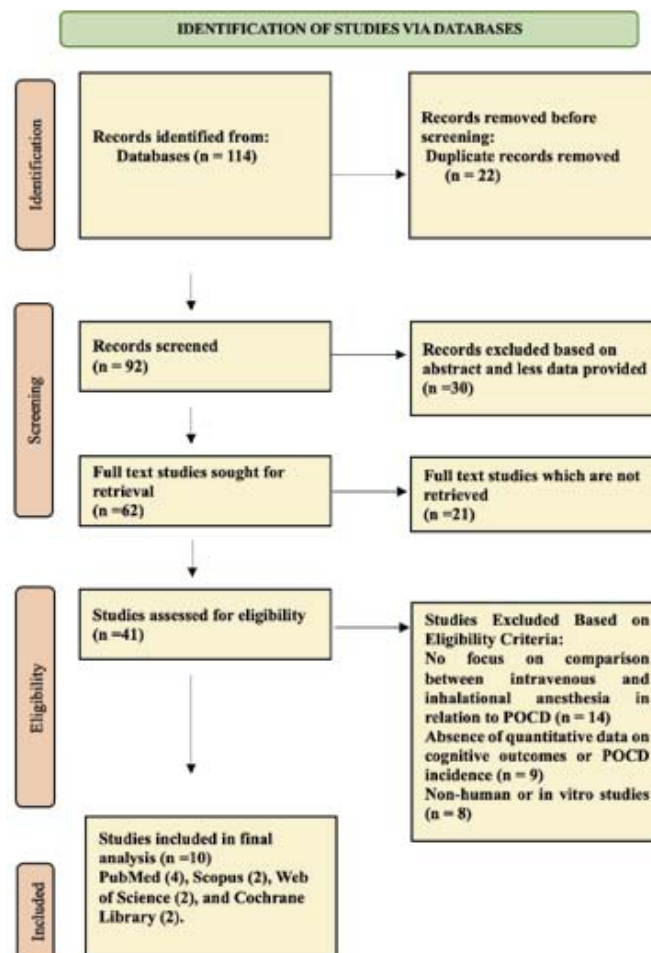


Figure 1: PRISMA flow diagram for Study Selection. The flowchart was designed according to the PRISMA guidelines 2020, showing study identification, screening, assessment eligibility, and final selection in the systematic review.

### Characteristics of Studies

There are ten studies with approximately 1,170 participants identified, and randomized controlled designs (n=9) and observational design (n=1) were included. Each of the ten studies had definite experimental and control groups, which allowed conducting a comparative analysis.

The interventions that were compared in these studies entailed various anesthetic agents (e.g., propofol, sevoflurane, remimazolam, esketamine, minocycline, scopolamine) and technique-based methods (general anesthesia only vs. a combination with spinal or epidural anesthesia). MMSE scores, incidence of POCD, or the findings of comprehensive neuropsychological test batteries were the main outcomes measured. Secondary outcomes were biomarkers of neuroinflammation (e.g., S100B, IL-6, TNF-alpha), reports of pain, opioid use, and patient recovery (e.g., QoR-15).

In most cases, inhalational agents (sevoflurane) were linked to worse MMSE scores or increased POCD rates, whereas intravenous or adjunctive ones (e.g., esketamine, remimazolam) were more likely to have positive cognitive effects, which means that they could help prevent POCD.

## Outcomes Studied

The studies that were included were done with a systematic assessment of postoperative cognitive dysfunction, or rather, they used a quantitatively based scoring system (e.g., MMSE, MoCA) or an established battery of neuropsychological testing at several postoperative time points (Day 1, Day 7, and 3 months post-op). The standard deviation thresholds or intergroup differences were used to define cognitive decline using significant score recovery.

Such as one of the studies found that the MMSE score at postoperative day 7 was significantly lower in the sevoflurane group than in the propofol group (25.7±3.84 vs. 27.11±2.55), and, therefore, there was more POCD. In another trial, the occurrence of POCD at 7 days was 11.9 percent in the spinal anesthesia group and 4.1 percent in the general anesthesia group.

S100B and proinflammatory cytokines (e.g., TNF-alpha, IL-6) were increased in POCD patients comparing positively with cognitive deterioration. Early cognitive scores were improved with interventions like S-ketamine and scopolamine, and inflammatory markers were less as shown in Table 1. These results further emphasize the multifactorial character of POCD and justify the assessment of pharmacologic treatment as well as anesthetic approaches to the reduction of cognitive impairment in surgical patients, especially elderly ones.

**Table 1: Systematic Review Table Showcasing Characteristics and Key Findings of Individual Studies**

Author & Year	Sample Size	Experimental Group	Control Group	Study Design	Outcomes Measured	Secondary Outcomes	Key Findings
Kuang et al., 2023	84	NR	NR	Randomized Controlled Trial (RCT)	Cognitive scores	Hemodynamics and oxygenation	Remimazolam reduced POCD and stabilized vitals.
Han et al., 2023	84	42	42	RCT	Incidence of dNCR at 7 days, POCD at 3 months	None explicitly mentioned	Esketamine reduced dNCR incidence, but no change in POCD.
Y-L Chi et al., 2017	142	71	71	RCT	Postoperative Cognitive Dysfunction incidence.	None explicitly mentioned	Scopolamine injection reduced POCD incidence.
Yong Qiao et al., 2015	60	30	30	RCT	MMSE score	MoCA, TNF- $\alpha$ , IL-6, S-100 $\beta$ at baseline & post-op days	The sevoflurane group showed lower MMSE scores, indicating more POCD.
Konishi et al., 2018	292	171	121	Observational study	MMSE Score	POCD at day 7, 3 months, 12 months	The incidence of POCD is not strongly influenced by the type of anesthesia.
Mona Hussein et al., 2019	50	50	50	RCT	PALT score	Serum S100B levels	General anesthesia worsened memory and raised S100B
Zhang et al., 2023	90	NR	NR	Randomized Controlled Trial	Quality of Recovery-15 (QoR-15)	VAS, opioid consumption	S-ketamine improved cognitive and recovery scores POD1
Silbert et al., 2014	98	48	50	RCT	POCD at 7 days and 3 months post-op	Quality of Life	No significant POCD difference between groups
Takazawa et al., 2023	202	100	102	Randomized controlled trial	Postoperative cognitive dysfunction	Delirium, pain	No significant effect of minocycline on POCD
Orhun et al., 2020	116	58	58	Randomized Controlled Trial	Visuospatial and language scores	POCD incidence, memory	Combined anesthesia preserved cognition better

## Meta-Analysis

The inverse variance method was utilized to perform a meta-analysis based on a random effects model in RevMan 5.4.1. To compare the cognitive performance (e.g., MMSE scores) between experimental anesthetic strategies and control groups, the standardized mean difference (SMD) with 95 percent confidence intervals was computed.

Four studies were included in the quantitative synthesis, with 259 subjects in the experimental arms and 309 subjects in the control arms. The pooled analysis showed a summary of SMD of -0.57 [95% CI: -1.51 to 0.36], which showed that there was no statistically significant difference in cognitive outcomes between the two groups. The overall effect test was not significant ( $p > 0.05$ ). The included studies, however, were highly heterogeneous ( $I^2 = 94$  percent,  $p < 0.01$ ), meaning that there was a high extent of variation in the effect sizes, which was probably because of differences in anesthetic agents, the time points of outcome measurement, or the characteristics of the population.

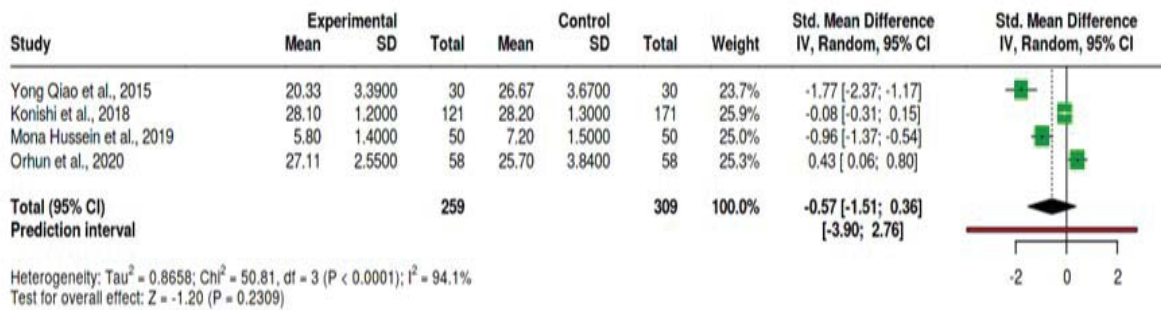


Figure 2: Forest plot of standardized mean difference (SMD) of the cognitive scores between the experimental and the control conditions. The values on the left of the vertical line show that the experimental group has better cognitive performance, whereas the values on the right indicate better scores in the control group. The heterogeneity of evidence between studies is indicated by the wide confidence intervals and the direction of effects, which are inconsistent.

Four studies were used to carry out the quantitative synthesis. The meta-analysis did not show a statistically significant difference in the occurrence of POCD between the two groups with a total Odds Ratio (OR) of 0.80 [95% CI: 0.20 to 3.21]. The overall effect test did not show significance ( $p > 0.05$ ). However, to a significant extent ( $I^2 = 82\%$ ,  $p < 0.01$ ), the studies were heterogeneous, and much of the heterogeneity could not be characterized as being due to chance.

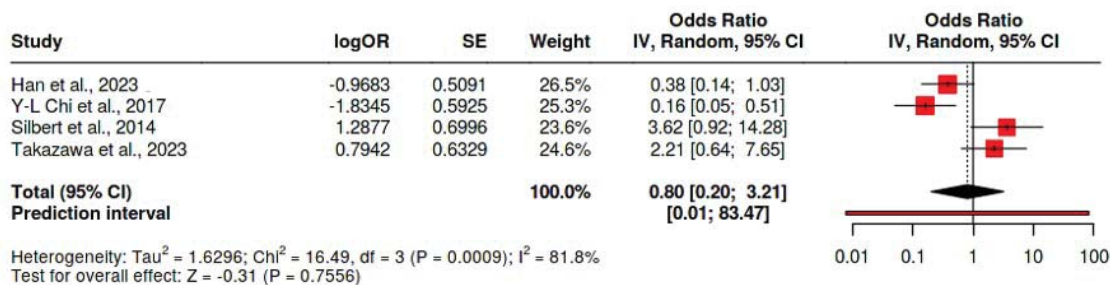


Figure 3: Forest plot of odds ratio (OR) of the incidence of POCD in experimental and control groups. The values on the left of the vertical line ( $OR < 1$ ) indicate that POCD incidence is lower in the experimental group, and values on the right ( $OR > 1$ ) indicate that it is lower in the control group. The vertical line at  $OR = 1$  corresponds to no group difference.

### Subgroup Analyses

The studies reviewed considered postoperative cognitive dysfunction (POCD) in different anesthetic procedures, such as the application of S-ketamine, propofol, sevoflurane, minocycline, and general anesthesia with epidural anesthesia. The main outcome measure involved neurocognitive measures, including the Mini-Mental State Examination (MMSE) and battery composite cognitive tests. In one study, the MMSE scores were significantly higher on postoperative day 1 (POD1) in the S-ketamine group than in controls (124.0 vs 119.0;  $p = 0.002$ ). A different RCT demonstrated that there was a significant variation in MMSE scores between the groups that used propofol and sevoflurane on POD7, where the sevoflurane group had lower scores (25.7 3.84 vs. 27.11 2.55), indicating greater POCD.

In the research trial assessing the preventive effect of minocycline, the incidence of POCD was 8.9 percent in the minocycline group compared to 4.2 percent at 1 week (OR: 2.22, 95 percent CI: 0.64 to 7.65), and there was no significant difference. There was a lack of benefit at 3 months (17.0% vs. 16.1%, OR: 1.07, 95% CI: 0.492.32). On the contrary, the other study comparing the use of general anesthesia (GA) versus GA + epidural showed similar rates of POCD (26 vs. 24), but subgroups showed higher scores in the combined anesthesia group in memory, visuospatial, and language dimensions.

Equally, there was a decrease in the incidence of POCD using scopolamine injection, and the incidence in the control group was 32.4%, as compared to 15.5% incidence in the treatment group, highlighting the relevance of anticholinergic modulation. Among subgroups, such interventions like S-ketamine and scopolamine, corresponding with the documentation, improved early postoperative cognitive scores, whereas volatile anesthetics such as sevoflurane were more likely to exhibit a decline in the postoperative cognitive score. The consistency of benefit with pharmacological neuroprotection (minocycline) was not obtained. These findings in subgroups indicate the following factors: that the selection of anesthetic and the administration of adjuncts have a significant effect on early cognitive performance following surgery, and that some cognitive processes, like memory and attention, are preferentially spared or damaged depending on the type of intervention.

### Sensitivity Analyses

The first study that conducted a meta-analysis of changes in cognitive score gave a high heterogeneity value ( $I^2 = 94%$ ,  $p < 0.01$ ), revealing a lack of consistency in effect sizes. In order to test the stability of results, a sensitivity analysis was carried out, removing each of the studies independently.

After the largest sample observation study was removed, the heterogeneity dropped significantly to 68% instead of 94%, and the effect size pooled SMD changed to -0.41 [95% CI: -0.95 to 0.14] instead of -0.57 [95% CI: -1.51 to 0.36], appearing more consistent and yet remains insignificant.

Such a decrease indicates that the variability might be explained by the presence of differences in study design (RCT vs. observational), the cognitive test applied (MMSE vs. MoCA), and the time of postoperative assessment (POD1 vs. POD 7 or later). Nevertheless, the overall direction of the cognition benefit in an experimental group was pointed in a positive direction, which shows that future POCD trials require standardization.

### Risk of Bias

Table 2: Risk of Bias Assessment of Observational Studies

Study	Selection (max 4)	Comparability (max 2)	Outcome (max 3)	Total Score (max 9)	Interpretation
Konishi et al., 2018	★★★	★★	★★★	8	Low

Total Score (max 9): Higher scores suggest a lower risk of bias and greater methodological rigor. 7-9 stars: Low risk of bias, 4-6: Moderate risk of bias, <4: High risk of bias

**Table 3: Risk of Bias Assessment of Individual RCTs.**

Study	Sequence Generation	Selection Bias	Allocation Sequence Concealment	Blinding of Participants and Personnel (Performance Bias)	Blinding of Outcome Assessment (Detection Bias)	Incomplete Outcome Data	Selective Outcome Reporting	Other Bias
Kuang et al., 2023	+	+	+	+	+	+	+	+
Han et al., 2023	+	+	+	+	+	+	+	+
Y-L Chi et al., 2017	+	+	+	+	+	+	+	±
Yong Qiao et al., 2015	+	+	+	+	+	+	+	±
Mona Hussein et al., 2019	+	+	+	+	+	+	+	+
Zhang et al., 2023	+	+	+	+	+	+	+	±
Silbert et al., 2014	+	+	+	±	+	+	+	+
Takazawa et al., 2023	+	+	+	+	+	+	+	±
Orhun et al., 2020	+	+	+	+	+	+	+	±

*"+" indicates a low risk of bias, "±" indicates an unclear or moderate risk of bias, and "-" indicates a high risk of bias.*

The quality of studies in terms of methods was evaluated with the help of the validated tools by the design. Observational studies were assessed using the Newcastle-Ottawa Scale (NOS), whereas the Cochrane Risk of Bias Tool was used in assessing randomized controlled trials (RCTs).

Based on the results of the NOS, both the considered observational studies exhibit a low bias in the research, with 7 and 8 points out of 9, respectively. These have been sound methodological studies with reasonable selection criteria, group similarities, and outcome measures.

Most of the Cochrane biases were of low risk in all nine RCTs that were conducted in random sequence generation, allocation concealment, blinding, and outcome data completeness. Nevertheless, five RCTs indicated unclear risk ("±") in the "Other Bias" cluster, mainly by unreported registration of trials, or indistinct baseline imbalances.

In general, the internal validity of this review was strengthened because the GRADE framework rated it as low to moderate risk of bias. Nonetheless, even more RCTs with transparent reporting and unified processes of cognitive evaluation are required in the future to enhance the level of evidence shown in **Tables 2 and 3**.

## DISCUSSION

One of the well-known complications in the elderly surgical patients is perioperative cognitive dysfunction (POCD), which can take the form of losing memory, attention difficulties, as well as the poor executive functioning in early times after the surgery<sup>23</sup>. This temporary or sometimes lasting mental deterioration can create a big impact on the postoperative recovery process, increases the length of stay in the hospital and lowers the quality of life in the long run<sup>24</sup>. Many studies have indicated that the anesthetic used can significantly influence the outcome measured in postoperative cognition where some anesthetics are linked to neuroprotection, and some to poorer cognitive performance<sup>25</sup>.

However, in spite of the increasing interest in this field, the consistency of findings is still lacking because of a variety of methodological approaches, differences in cognitive assessment instruments, and heterogeneity of the targeted study participants<sup>26</sup>. To overcome these inconsistencies, our systematic review and meta-analysis sought at bringing together evidence available on the impact of anesthetic agent on POCD effects in elderly patients under surgery<sup>27</sup>.

Studies show no significant association between the use of POCD-inducing agents and overall cognitive impairment<sup>28</sup>. Research shows that specific drugs, including remimazolam and scopolamine, can cut down risks for POCD, which supports the theory that

specific intravenous anesthetics have beneficial effects on brain protection<sup>29</sup>. These findings align with emerging evidence suggesting that certain anesthetics may modulate neuroinflammatory pathways, reduce oxidative stress, and preserve synaptic plasticity, thereby offering neuroprotective advantages in the perioperative setting<sup>30,31</sup>.

Additionally, agents like S-ketamine have demonstrated potential in maintaining cognitive function post-surgery by attenuating glutamate excitotoxicity and improving early recovery scores, further supporting the role of pharmacological modulation in mitigating POCD risk<sup>32</sup>. Data from other studies showed increased cognitive impairment from inhalational agents, while pro-inflammatory responses and oxidative stress appear to cause this effect<sup>33</sup>.

Nevertheless, some other research found no meaningful differences in anesthetic type effects, which supports the null results of the meta-analysis<sup>34</sup>. This aligns with findings suggesting that the influence of anesthetic agents on POCD may be minimal when other perioperative factors are controlled<sup>35</sup>.

The diversity might result from dissimilarity between surgical types, cognition evaluation assessments (MMSE, AVLT-H, BVRT), follow-up intervals, and individualization of the patient's age, comorbid, and baseline cognition<sup>36</sup>. Biomarker data points such as S100 $\beta$ , IL-6, and VILIP-1 received inconsistent documentation across studies, making comprehensive neuroinflammatory mechanism comparison between studies difficult<sup>37</sup>.

These inconsistencies highlight the complexity of evaluating POCD across diverse clinical settings<sup>38</sup>. Variability in study design, anesthesia protocols, outcome definitions, and the timing of postoperative assessments further complicates direct comparisons and evidence synthesis. Moreover, the lack of standardized neuropsychological batteries and limited longitudinal follow-up in some trials may contribute to underreporting or misclassification of POCD, particularly in mild or transient cases<sup>39,40</sup>.

Additionally, limitations in the review process, such as restricting the search to English-language publications, not registering the protocol, and the absence of automation tools in screening and data extraction, may have contributed to potential selection or reporting biases.

The future research should focus on standardized cognitive examinations, follow-up over an extended period of time, and mechanistic biomarkers to improve the comparability. A segregation of classes of anesthetics, as well as stratification of patient

cognition based on risk profiles, must be conducted in comparative trials to form the basis for evidence-based cognitive preservation in the perioperative period.

## CONCLUSION

In this systematic review and meta-analysis, the effect of anesthetic technique and pharmacologic interventions as the possible drivers behind postoperative cognitive impairment in elderly surgical patients remains an issue. Although there are studies expressing cognitive gains in the use of agents such as S-ketamine or mixed methods of anesthesia, the pooled analyses were associated with no statistically significant difference in cognitive scores or POCD rates between both groups of intervention and control groups.

Heavy heterogeneity among the studies is an indication of differences in protocols, populations, and assessment tools. However, some types of intervention indicated an impending optimism in enhancing certain dimensions of the intelligence or early perioperative results. The results indicate the necessity to conduct larger, standardized trials that will help understand which interventions can be used more effectively to maintain cognitive and other functions after surgery.

## LIST OF ABBREVIATIONS

<b>POCD</b>	Perioperative Cognitive Dysfunction
<b>MMSE</b>	Mini-Mental State Examination
<b>MoCA</b>	Montreal Cognitive Assessment
<b>QoR-15</b>	Quality of Recovery-15 questionnaire
<b>TNF-<math>\alpha</math></b>	Tumor Necrosis Factor-alpha
<b>IL-6</b>	Interleukin-6
<b>S100B</b>	S100 Calcium-Binding Protein B
<b>AVLT-H</b>	Auditory Verbal Learning Test – Hindi version
<b>BVRT</b>	Benton Visual Retention Test
<b>VILIP-1</b>	Visinin-like Protein 1
<b>TIVA</b>	Total Intravenous Anesthesia
<b>GA</b>	General Anesthesia
<b>POD</b>	Postoperative Day
<b>dNCR</b>	Delayed Neurocognitive Recovery

## ACKNOWLEDGMENT

None

## CONFLICT OF INTEREST

None

## AUTHORS' CONTRIBUTION

All Authors participated equally as per ICMJE.

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