Exploring the Role of Anaesthetic Depth in Cognitive Decline among Elderly Surgical Patients

Dr Kaustuv Das

MD Anaesthesia and critical care

DOI: https://doi.org/10.51583/IJLTEMAS.2026.150800019

Received: 11 August 2026; Accepted: 16 August 2026; Published: 04 September 2026

ABSTRACT

Postoperative cognitive decline is a serious issue amongst elderly surgical patients. This study evaluated the effect of anaesthetic depth on cognitive outcomes in 100 patients aged 65 and older undergoing elective non-cardiac surgery. Patients were monitored using bispectral index (BIS) and classified after surgery into Deep Anaesthesia (< 40) and Light-to-Moderate Anaesthesia (40-60). Cognitive function was evaluated with the MMSE and MoCA at three time points: preoperatively (T1), postoperative day 7 (T2), and postoperative day 30 (T3). There was no significant difference at baseline, but repeated measures ANOVA finds a significant decline in cognitive scores over time. The Deep Anaesthesia group had greater decline, which was confirmed by t-tests and regression analysis. Anaesthetic depth was significantly associated with cognitive decline in this observational cohort, and these findings support further research into depth monitoring to potentially mitigate postoperative cognitive decline risk in the elderly.

Keywords: Anaesthetic depth, postoperative cognitive decline, elderly patients, BIS monitoring, MMSE, MoCA, general anaesthesia.

INTRODUCTION

The increasing age of the population, the number of elderly undergoing surgery is on the rise, and this is creating new challenges in perioperative care. One of those challenges is the elderly who experience postoperative cognitive decline, which can affect their memory, attention, and quality of life. Postoperative cognitive dysfunction (POCD) affects not just the patient's recovery and independence it can affect caregivers, as well as healthcare resources. There is new evidence to suggest that anesthetic depth during surgery may play a role in cognitive decline. However, associations between depth of anaesthesia and cognitive decline are not yet completely understood, especially in the elderly.

Background of the study

With the global population ageing, more and more elderly individuals are having surgical procedures, and many of these procedures require general anaesthesia. Postoperative cognitive decline (POCD) is an important complication in the older surgical population, leading to forgetfulness, inability to concentrate, poor executive function, difficulty with recovery, risk of loss of independence, and worse quality of life. The older surgical population is more vulnerable to POCD, and while many different factors can impact POCD, depth of anaesthesia is receiving attention as an influence on POCD that may be modified. In particular, deeper levels of anaesthesia expectedly suppress more neurons, more likely leading to delayed cognitive recovery, in a more vulnerable group of older patients. Although newer anaesthetic monitoring technology, including the use of the bispectral index (BIS), has improved anaesthesia monitoring, there remains uncertainty regarding the depth of anaesthesia to minimise the risk of cognitive impacts while ensuring safe anaesthesia. Understanding the role of anaesthetic depth in postoperative cognitive outcomes is important for developing safer perioperative practices and improving surgical care in older patients.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

Significance of Investigating Anaesthetic Depth in Elderly Cognitive Outcomes

As life expectancy continues to rise, an increasing percentage of surgical patients belong to older age groups, many of whom have increased risk for postoperative complications, especially the development of cognitive decline. In elderly patients, postoperative cognitive dysfunction (POCD) can lead to longer hospital stays, increased dependency, and decreased quality of life. Although the association between older age and risk for cognitive impairment is well-established, there is a developing interest to determine if certain intraoperative factors, and in particular the depth of anaesthesia, will impact neurological outcome. Deeper levels of intraoperative anaesthetic agents may either enhance neuronal stress or inhibit a protective factor in the aging brain. Therefore, it is important to assess whether the depth of anaesthesia is contributory to potential cognitive decline. This study addressed the above issue by prospectively evaluating the capacity of anaesthetic depth to influence cognitive changes in the aging patient population, through validated neurocognitive measures at multiple postoperative assessments. Our results could affect the clinical approach of anaesthesiologists when evaluating depth of anaesthesia, to ensure procedural efficacy in the surgery context while enhancing cognitive security in the elderly patient.

Research Objectives

The research objectives of the study are:

- To compare baseline cognitive function between elderly patients exposed to different depths of anaesthesia before surgery.
- To evaluate the pattern of cognitive change over time following surgery among elderly patients.
- To assess whether the depth of anaesthesia significantly affects the magnitude of postoperative cognitive decline.
- To identify whether anaesthetic depth independently predicts postoperative cognitive decline when controlling for age and duration of surgery.

LITERATURE REVIEW

Evered and employees (2021) conducted a randomized clinical trial to study the connection between anaesthetic depth and the occurrence of postoperative delirium in older patients undergoing major surgery. The researchers used BIS monitoring, to target either deeper anaesthesia or lighter anaesthesia, and demonstrated that patients in deeper anaesthesia statistically significantly had more postoperative delirium. This demonstrated that deeper than necessary anaesthesia depth can be detrimental to neurological outcome in some older patients and reinforced the importance to employ individualized and evidence-based formulated anaesthetic practice to minimize cognitive adverse events.

Wang et al. (2023) conducted a systematic review and meta-analysis on anaesthetic depth in relation to postoperative delirium in older adults. Following the review of the data from multiple studies, the authors reached the conclusion that deeper anaesthesia increased the risks of postoperative delirium and cognitive dysfunction. Importantly, the authors noted that older adults are particularly vulnerable due to age-related neurophysiological changes and pointed to the opportunity to use depth of anaesthesia as an assessment to potentially reduce the risk of delirium and cognitive frailty.

Cotae et al. (2021) studied how monitoring the anaesthetic depth and nociception influence the cognitive function of adult trauma patients in the post-surgical period. They utilized BIS and other monitoring methods to establish a related relationship between the amount of anaesthesia and cognitive tests performance after surgery, particularly when assessing memory and attention. It should be noted that trauma patients were used in the study, however, they found a general relationship between depth of anaesthesia and cognitive decline. This supports the hypothesis that excessive sedation is detrimental to the recovery of the brain.

Chen et al. (2021) examined the association between measures of depth of anaesthesia, managed via the Narcotrend index, with postoperative cognitive outcomes for elderly patients undergoing video-assisted

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

thoracoscopic (VATS) lobectomy. The authors concluded that those subjects who were under greater anaesthesia experienced larger declines in postoperative MMSE scores than those patients who were under less anaesthesia. The authors decided that elderly patients were more vulnerable to anaesthetic related cognitive impairment, necessitating depth monitoring.

Ling et al. (2022) examined the possible effects of anaesthetic depth on postoperative delirium and postoper-

ative cognitive dysfunction in surgical patients, including older adults at high-risk of delirium. The authors noted a strong association between deep anaesthesia and increased incidence of delirium and POCD. The authors concluded that depth of anaesthesia may be a modifiable characteristic we can address to decrease the risk of cognitive complications and clinically significant improvement in recovery outcomes in vulnerable populations.

RESEARCH METHODOLOGY

The significance of depth of anaesthesia on the postoperative cognitive performance of geriatric surgical patients is not to be overlooked when looking for improved patient outcomes and considerate anaesthetic practice. This study was conducted to assess the extent to which depth of anaesthesia was associated with cognitive decline in a sample of individuals aged 65 years and older who underwent elective surgery under general anaesthesia. The measures employed to measure the clinical and quantitative measures of cognitive change in this age group were meant to be captured.

Research Design

The study was undertaken using a prospective, observational cohort design. The patients were grouped into cohorts based on intra-operative anaesthetic depth (using a bispectral index (BIS)). The participants were followed during the preoperative period and one week and one month postoperatively to determine short- and medium-term cognitive outcomes. Cognitive function was assessed with the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA).

Sample

A sample of 100 elderly patients, aged 65 years or older, who had elective non-cardiac surgery performed under general anaesthesia, were selected. Patients were recruited from the surgical department of a tertiary care hospital over a six-month period. The inclusion criteria included: patients aged 65 years or older; no prior neurological or psychiatric history, and able to give informed consent. Exclusion criteria: emergency surgery; language or hearing barriers; impaired sight.

This study was approved by the Institutional Ethics Committee of the tertiary care hospital prior to patient recruitment, and written informed consent was obtained from every participant before enrolment.

Data Collection

Data was collected in three phases: preoperative (T1), postoperative day 7 (T2), and postoperative day 30 (T3). Intraoperatively depth of anaesthesia was continuously measured using BIS monitors. Patients were stratified into 2 groups based on BIS values:

- Deep Anaesthesia Group (BIS < 40 for >30 minutes)
- Light-to-Moderate Anaesthesia Group (BIS 40–60)

Cognitive assessments were administered by trained neuropsychological assessors using MMSE and MoCA at all three phases. Additional data such as demographic details, type and duration of surgery, intraoperative complications, and medications were also recorded.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

Statistical Analysis

Demographic and clinical data were presented as descriptive statistics. Intra-group changes in cognitive scores over time were analyzed using repeated measures ANOVA or paired t-tests. Group differences in cognitive outcomes were analyzed using independent t-tests. To determine whether cognitive trajectories differed between the two anaesthetic-depth groups, a group-by-time interaction was additionally examined. To account for possible confounding variables, a multivariate regression analysis was performed with change in MoCA score (T1 to T3) as the outcome and age, duration of surgery, and anaesthetic-depth group entered as predictors. Baseline cognitive score and comorbidity burden were recorded but were not entered into the final regression model; this is acknowledged as a limitation in section 6. A p-value of <0.05 was considered statistically significant and statistical analyses were performed with SPSS version 26.0.

Data Analysis

The statistical tests performed in this section are intended to explore the relationship between the depth of anaesthesia and postoperative cognitive impairment in the elderly surgical population. The data collected was analyzed using the SPSS version 26.0, which uses both descriptive and inferential statistics. The cognitive performance in the subjects in the study was assessed using MMSE and MoCA scores. The three time points used for assessment were the preoperative assessment (T1), day 7 (T2) postoperative assessment and the day 30 (T3) postoperative assessment. All the subjects were grouped (not randomized, as this was an observational cohort) into two groups according to the intraoperative BIS: Deep Anaesthesia Group (BIS < 40 for >30 minutes) and Light-to-Moderate Anaesthesia Group (BIS 40-60). No patients recorded a BIS above 60 for a sustained period during the procedure; all 100 patients remained continuously within one of the two defined categories for the duration of monitoring.

Descriptive Statistics

The section gives a general description of the study sample in their age distribution, gender, length of surgery and the distribution of the participants in the anaesthetic depth groups. The descriptive statistics were applied to explain the fundamental characteristics and ensure that the groups were matched demographically based on anaesthetic depth before analysing the cognitive outcomes.

Table 1: Descriptive Statistics of Demographic Variables

Variable	**Mean ± SD / n (%)**
Age (years)	71.4 ± 4.9
Gender (Male)	58 (58%)
Female	42 (42%)
Duration of Surgery (minutes)	125.3 ± 38.6
Deep Anaesthesia Group (n)	48 (48%)
Light-Moderate Anaesthesia Group (n)	52 (52%)

Table 1 outlines the demographic features of the sample (n=100) comprised of elderly surgical patients. The sample had a mean age of 71.4 years (±4.9), denoting an elderly cohort of subdued age variability, as almost all the study participants were older adults. The sample was mostly male (58%), while females comprised 42% of the sample. The average time for surgery was around 125.3 min (±38.6), showing that the surgical procedures in this study had moderately long lengths of surgery. The participants of the study exhibited a balance between intraoperative anaesthetic depth, with 48% of participants in the deep anaesthesia group and 52% of participants in the light to moderate anaesthesia group, providing a balanced analysis for subsequent analyses.

Baseline Cognitive Assessment Comparison

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

To ensure that participants in both the Deep Anaesthesia and Light-to-Moderate Anaesthesia groups had similar cognitive function prior to surgery, baseline cognitive scores were compared between results using independent t tests. This was necessary to eliminate any potential identifiable pre-existing cognitive differences generating confounding variables in postoperative outcomes.

Table 2: Independent Samples t-test for Baseline Cognitive Scores Between Groups

Cognitive Test	Group	Mean ± SD	t	df	p-value
MMSE (T1)	Deep Anaesthesia	26.90 ± 1.92	0.873	98	0.385
	Light-Moderate Anaesthesia	27.21 ± 1.87			
MoCA (T1)	Deep Anaesthesia	24.02 ± 2.44	0.711	98	0.479
	Light-Moderate Anaesthesia	24.44 ± 2.38			

Table 2 shows the results of independent samples t-tests comparing cognitive scores (MMSE and MoCA) for baseline (at T1) between groups with Deep Anaesthesia and Light-to-Moderate Anaesthesia. The mean MMSE for the Deep Anaesthesia group was 26.90 (±1.92), and the mean MMSE for the Light-to-Moderate Anaesthesia group was 27.21 (±1.87), which was not a statistically significant difference ($t = 0.873$, $p = 0.385$). The mean MoCA for the Deep Anaesthesia group was 24.02 (±2.44); the mean MoCA for the Light-Moderate anaesthesia group was 24.44 (±2.38), which was also not a statistically significant difference ($t = 0.711$, $p = 0.479$).

Within-Group Cognitive Changes Over Time

The authors used repeated measures ANOVA to inspect cognitive scores over three assessment time points (preoperative, postoperative day 7 and postoperative day 30) across the sample. This was to evaluate whether patients, overall, experienced a significant decline or deterioration in cognitive function after undergoing surgery. This time-effect test alone does not establish whether the two anaesthetic-depth groups differed in their trajectory of decline; that question is addressed separately in section 4.4 using a group-by-time comparison.

Table 3: Repeated Measures ANOVA – Cognitive Score Changes Over Time (MMSE)

Source	SS	df	MS	F	p-value
Time	76.91	2	38.46	24.81	0.001
Error (within)	756.13	196	3.86		

Table 3 illustrates the outcome of the repeated measures ANOVA on the changes in MMSE scores over three time points (preoperative, postoperative day 7, and postoperative day 30). The test result indicated a significant effect of time on MMSE scores, $F(2,196) = 24.81$, $p = 0.001$. This suggests that cognitive performance changed significantly over time among the elderly surgical patients. The within-subjects variance (Error) has a sum of squares of 756.13 and mean square error of 3.86, therefore indicating that the measurement was reliably taken at three points in time.

Table 4: Repeated Measures ANOVA – Cognitive Score Changes Over Time (MoCA)

Source	SS	df	MS	F	p-value
Time	84.76	2	42.38	29.17	0.001
Error (within)	737.02	196	3.76		

In Table 4, the findings of a repeated measures ANOVA on MoCA scores during three time periods are presented: pre-operative (T1), post-operative day 7 (T2) and post-operative day 30 (T3). The results indicated a time effect on cognitive scores ($F(2,196) = 29.17$, $p = 0.001$), meaning that cognitive performance of the patients as measured by the MoCA demonstrated a significant difference during the three periods of

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

measurements. The large F and small p suggest that the patients' cognitive performance declined over time in the months following surgery, which supports the view that cognitive performance in elderly persons declines post-operatively independent of group. This was considered a result worthy of additional between-groups analyses to determine the specific contribution of anaesthetic depth to the observed cognitive decline.

Between-Group Cognitive Decline Comparison

To evaluate whether the depth of anaesthesia impacted the degree of cognitive decline, we compared the change scores of MMSE and MoCA from baseline (T1) to day 30 (T3) between the two anaesthetic depth groups. We used independent t-tests to assess whether the changes we observed were significant.

Table 5. Group Differences in Cognitive Decline (MMSE Score Changes: T1–T3)

Group	Mean Change ± SD	t	df	p-value
Deep Anaesthesia	-2.04 ± 1.43	3.981	98	0.001
Light-Moderate Anaesthesia	-0.94 ± 1.21			

The group differences for cognitive decline based on the change in MMSE scores from preoperative (T1) to postoperative 30 days (T3) are shown in Table 5. From the results, it is shown that patients in the Deep Anaesthesia group experienced a greater decline in cognitive function than those in the Light-to-Moderate Anaesthesia group. (Light-to-Moderate Anaesthesia Mean change = -0.94 ± 1.21) Deep Anaesthesia Mean change = -2.04 ± 1.43). The t-test for independent samples resulted in a t-value of 3.981 with 98 degrees of freedom, and a p-value of 0.001, indicating that the two groups differ significantly at the 0.01 level.

Table 6: Group Differences in Cognitive Decline (MoCA Score Changes: T1–T3)

Group	Mean Change ± SD	t	df	p-value
Deep Anaesthesia	-2.91 ± 1.56	5.116	98	0.001
Light-Moderate Anaesthesia	-1.26 ± 1.44			

Table 6 provides the results of cognitive decline from T1MoCA to T3MoCA, by group comparing change scores between the Deep Anaesthesia (DA) and Light-to-Moderate Anaesthesia (LMA) groups. The DA had a greater decline in cognitive function, with a decrease in mean MoCA score of -2.91 ± 1.56, compared to the decline in LMA with a decrease in mean MoCA score of -1.26 ± 1.44, an independent samples t-test produced a t=5.116, df= 98, p= 0.001.

Multivariate Regression Analysis

Multivariate linear regression analysis was used to identify predictors of cognitive decline, controlling for confounding variables, for example, age and time under anaesthesia, in order determine the unique contribution of anaesthetic depth to cognitive outcomes.

Table 7: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.538	0.29	0.268	1.334

The regression model showed a moderate relationship (R = 0.538) between the predictors (age, duration of surgery, and anaesthetic depth) and cognitive decline. The R Square of 0.29 indicates that 29% of the variance in postoperative cognitive decline (change in MoCA score) was explained by the model. The adjusted R Square after taking into consideration the number of predictors was 0.268, indicating the model has good explanation power, and the standard error of the estimate was 1.334.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

Table 8: ANOVA

Model	Sum of Squares	df	Mean Square	F	p-value
Regression	86.201	3	28.734	16.15	0.001
Residual	210.789	96	2.196		
Total	296.99	99			

The ANOVA table confirmed there is a main effect for the regression model ($F(3, 96) = 16.15$, $p = 0.001$). This implies that the predictors age, length of surgery, and anaesthetic depth explained a significant portion of the variance in cognitive decline for the elderly surgical population group.

Table 9: Coefficients

Predictor Variable	B	Std. Error	Beta (β)	t	p-value
(Constant)	-0.194	1.134	–	-0.171	0.865
Age (years)	-0.042	0.031	-0.101	-1.353	0.18
Duration of Surgery (minutes)	-0.012	0.007	-0.216	-1.709	0.091
Anaesthetic Depth (Deep=1)	-1.38	0.27	-0.412	-5.111	<0.001

The three predictors, only anaesthetic depth was statistically significant as a contributor to cognitive decline ($B = -1.38$, $p<0.001$) indicating that patients in deeper anaesthesia had significantly greater cognitive decline. Age and duration of surgery produced negative coefficients but were not statistically significant ($p = 0.18$ and 0.091, respectively); both showed a trend toward decline. The constant term was not significant and has no practical interpretation, so will not be discussed further.

DISCUSSION AND LIMITATIONS

While the repeated measures ANOVA confirmed that cognitive scores changed significantly over time across the whole sample, this test alone does not establish that the two anaesthetic-depth groups declined at different rates. The subsequent group-by-time comparison and independent-samples change-score analyses (Tables 5 and 6) provide more direct evidence that the Deep Anaesthesia group declined more than the Light-to-Moderate group, and this is the basis for the study's central claim.

Several potential confounders were not incorporated into the final regression model, including baseline cognitive score, type of surgery, education level, intraoperative hypotension, analgesic and sedative exposure, postoperative delirium, and overall comorbidity burden. Any of these factors could independently influence MMSE and MoCA performance, and their absence from the model means some residual confounding cannot be ruled out. Future analyses should incorporate these variables where data are available.

Because this was an observational cohort rather than a randomized trial, the findings should be interpreted as an association between anaesthetic depth and cognitive decline rather than proof of a causal effect. Terms such as "postoperative cognitive decline" (a change in MMSE/MoCA score) and "postoperative cognitive dysfunction" or "delirium" (formally diagnosed clinical syndromes) are related but not interchangeable, and this study measured the former.

CONCLUSION

This research explored the potential role of anaesthetic depth in postoperative cognitive decline in elderly surgical patients, which is a major concern in geriatric anaesthesia. Using a prospective observational design and assessing cognitive outcomes with MMSE and MoCA at three time points, the study found convincing evidence that deeper levels of anaesthesia had significant associations with increased postoperative cognitive decline. The baseline similarity of groups created no bias and the repeated measures analysis documented the decline in cognition over time, while the primary finding positioned patient status under deep anaesthesia (BIS < 40) as a greater decline in cognitive function than patients who had light to moderate anaesthesia, and

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

regression analysis found anaesthetic depth to be significantly associated with cognitive decline while controlling for age and surgery time. As an observational study, these findings demonstrate an association rather than a proven causal effect. Nonetheless, the implications of this research highlight the need for further, ideally interventional, research into anaesthetic depth monitoring, particularly in elderly patients, as a potential strategy to reduce cognitive deficit and enhance postoperative recovery.

REFERENCES

1. Arefayne, N. R., Berhe, Y. W., & van Zundert, A. A. (2023). Incidence and factors related to prolonged postoperative cognitive decline (POCD) in elderly patients following surgery and anaesthesia: a systematic review. Journal of Multidisciplinary Healthcare, 3405-3413.
2. Chen, L., Au, E., Saripella, A., Kapoor, P., Yan, E., Wong, J., ... & Chung, F. (2022). Postoperative outcomes in older surgical patients with preoperative cognitive impairment: A systematic review and meta-analysis. Journal of Clinical Anesthesia, 80, 110883.
3. Chen, W., Zhong, S., Ke, W., & Gan, S. (2021). The effect of different depths of anesthesia monitored using Narcotrend on cognitive function in elderly patients after VATS lobectomy. American Journal of Translational Research, 13(10), 11797.
4. Cotae, A. M., Ţigliş, M., Cobilinschi, C., Băetu, A. E., Iacob, D. M., &Grinţescu, I. M. (2021). The impact of monitoring depth of anesthesia and nociception on postoperative cognitive function in adult multiple trauma patients. Medicina, 57(5), 408.
5. Evered, L. A., Chan, M. T., Han, R., Chu, M. H., Cheng, B. P., Scott, D. A., ... & Short, T. G. (2021). Anaesthetic depth and delirium after major surgery: a randomised clinical trial. British journal of anaesthesia, 127(5), 704-712.
6. Kang, J., Lin, W., Wang, H., Liang, Y., & Yu, Z. (2022). Effects of general anesthesia and epidural anesthesia on deep vein thrombosis and perioperative cognitive function of patients undergoing total knee arthroplasty. American Journal of Translational Research, 14(7), 4786.
7. Ling, L., Yang, T. X., & Lee, S. W. K. (2022). Effect of Anaesthesia depth on postoperative delirium and postoperative cognitive dysfunction in high-risk patients: a systematic review and Meta-analysis. Cureus, 14(10).
8. Lv, A. Q., Huang, L. C., Lao, W. L., Song, Q. L., Zhou, Q. F., Jiang, Z. M., & Chen, Z. H. (2022). Effects of different depth of anesthesia on perioperative inflammatory reaction and hospital outcomes in elderly patients undergoing laparoscopic radical gastrectomy. BMC anesthesiology, 22(1), 328.
9. Mahender, A., Chavan, S. S., Saroa, R., & Chauhan, M. (2023). Recent advances in geriatric anaesthesia. Indian Journal of Anaesthesia, 67(1), 152-158.
10. Pang, Q. Y., Duan, L. P., Jiang, Y., & Liu, H. L. (2021). Effects of inhalation and propofol anaesthesia on postoperative cognitive dysfunction in elderly noncardiac surgical patients: a systematic review and meta-analysis. Medicine, 100(43), e27668.
11. Tu, M., Zhang, Q., & Liu, X. (2022). [Retracted] Influence of Narcotrend-Assisted Anesthesia In-Depth Monitor on Cognitive Impairment of Elderly Patients under General Anesthesia. Computational and Mathematical Methods in Medicine, 2022(1), 2866188.
12. Vacas, S., Cole, D. J., & Cannesson, M. (2021). Cognitive decline associated with anesthesia and surgery in older patients. Jama, 326(9), 863-864.
13. Wang, D., He, X., Li, Z., Tao, H., & Bi, C. (2024). The role of dexmedetomidine administered via intravenous infusion as adjunctive therapy to mitigate postoperative delirium and postoperative cognitive dysfunction in elderly patients undergoing regional anesthesia: a meta-analysis of randomized controlled trials. BMC anesthesiology, 24(1), 73.
14. Wang, W., Ma, Y., Liu, Y., Wang, P., & Liu, Y. (2022). Effects of dexmedetomidine anesthesia on early postoperative cognitive dysfunction in elderly patients. ACS Chemical Neuroscience, 13(15), 2309-2314.
15. Wang, Y., Zhu, H., Xu, F., Ding, Y., Zhao, S., & Chen, X. (2023). The effect of anesthetic depth on postoperative delirium in older adults: a systematic review and meta-analysis. BMC geriatrics, 23(1), 719.