INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

EVALUATING THE EFFECTS OF GENERAL ANESTHESIA ON POSTOPERATIVE DELIRIUM IN PATIENTS UNDERGOING SURGERY AT DHQ LAKKI MARWAT: A CROSS-SECTIONAL STUDY

Original Research

Furqan Shah[1], Hikmat Yar[2], Naseem Khan[3], Abdul Haleem[4], Muhammad Qasim Abbasi[5], Anas Bacha Shaheen[6]*

[1]Lecturer, Department of Anesthesia, Frontier Institute of Modern Sciences, Pakistan.
[2]Demonstrator, Department of Anesthesia Technology, Khyber Medical University Institute of Health Sciences, Lakki Marwat, Pakistan.
[3]Assistant Professor, Department of Occupational Therapy, Institute of Physical Medicine and Rehabilitation, Khyber Medical University, Peshawar, Pakistan.
[4]Lecturer, Department of Pharmacology, FIMS College, Mansehra, Pakistan.
[5]Research Associate, MS Pharmacy (Pharmacology), COMSATS University, Abbottabad Campus, Pakistan.
[6]Lecturer, Department of Surgical, Abasyn University, Peshawar, Pakistan.
Corresponding Author: Anas Bacha Shaheen, Lecturer, Department of Surgical, Abasyn University, Peshawar, Pakistan, anasbacha713@gmail.com
Acknowledgement: The authors sincerely thank the administration and staff of DHQ Hospital, Lakki Marwat, for their support and cooperation throughout the study.

Conflict of Interest: None
Grant Support & Financial Support: None

ABSTRACT

Background: Postoperative delirium (POD) is one of the most frequent and serious neurocognitive complications observed after surgery, especially among patients receiving general anesthesia. It manifests as an acute disturbance in attention and cognition, contributing to increased morbidity, prolonged hospital stay, and elevated healthcare costs. Despite its clinical significance, postoperative delirium remains under-recognized in many regional hospitals in Pakistan, where standardized screening and preventive protocols are limited.

Objective: This study aimed to evaluate the effects of general anesthesia on the development of postoperative delirium and to identify associated demographic, clinical, and anesthetic risk factors among surgical patients at District Headquarters (DHQ) Hospital, Lakki Marwat.

Methods: A descriptive cross-sectional study was conducted on 177 adult patients who underwent surgery under general anesthesia. Data were collected using a structured questionnaire and the Confusion Assessment Method (CAM) to assess delirium within 24–72 hours postoperatively. Collected variables included age, gender, ASA classification, type and duration of surgery, comorbidities, cognitive status, and ICU admission. Statistical analysis was performed using SPSS version 25. Descriptive statistics were used to summarize data, chi-square tests identified associations, and binary logistic regression determined independent predictors of postoperative delirium, with statistical significance set at $p < 0.05$.

Results: Postoperative delirium was identified in 19.2% (n = 34) of the 177 patients. Delirium was significantly more frequent among patients aged ≥65 years (50.0%), those with ASA class III–IV (67.6%), emergency surgeries (50.0%), and prolonged anesthesia duration exceeding 4 hours (38.3%). Preexisting cognitive impairment (32.4%), comorbidities (79.4%), and ICU admission (38.2%) were also significantly associated ($p < 0.05$). Logistic regression analysis revealed preexisting cognitive impairment (OR = 4.32), prolonged anesthesia (OR = 3.43), and advanced age (OR = 2.61) as independent predictors. The model exhibited good fit with a Nagelkerke R^2 of 0.41 and 84.2% overall accuracy.

Conclusion: Postoperative delirium is a relatively common complication following general anesthesia, particularly in elderly and medically compromised patients. Identification of high-risk individuals, optimization of preoperative status, and vigilant intraoperative and postoperative monitoring are crucial in reducing its incidence and improving recovery outcomes.

Keywords: Aged, Anesthesia (General), Cognitive dysfunction, Cross-sectional studies, Delirium (Postoperative), Risk factors, Surgical patients.

INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

INTRODUCTION

Postoperative delirium (POD) represents a transient yet severe neuropsychiatric disturbance that arises following surgical procedures, particularly among patients exposed to general anesthesia. It is defined as an acute and fluctuating impairment in attention, awareness, and cognition that develops within hours or days after surgery (1). This condition is not merely a transient postoperative reaction but a serious complication that contributes to increased morbidity, mortality, extended hospitalization, and long-term cognitive decline. In clinical practice, it is widely recognized as a key indicator of postoperative neurological dysfunction, reflecting the intricate interplay between anesthetic effects and cerebral vulnerability (2). The pathophysiology of postoperative delirium is multifactorial, encompassing anesthetic, physiological, and patient-related factors. General anesthesia, while essential for surgical safety and comfort, has been implicated as a potential trigger due to its influence on neurotransmitter balance, cerebral perfusion, and oxygen metabolism. Depth and duration of anesthesia, intraoperative hemodynamic fluctuations, and exposure to sedatives or opioids can significantly disrupt neural homeostasis and predispose susceptible individuals to delirium (3–6). Furthermore, patient-specific variables such as advanced age, preexisting cognitive deficits, systemic comorbidities, and perioperative physiological stress compound this risk. Evidence also suggests that emergency operations and extended anesthesia durations elevate the likelihood of postoperative cognitive disturbances (7,8).

Globally, the prevalence of POD varies widely, ranging from 10% to 50%, depending on surgical type, patient population, and diagnostic methods employed. Elderly individuals and those with chronic illnesses exhibit heightened vulnerability. However, in resource-limited settings such as Pakistan, the true burden of postoperative delirium remains poorly understood. The condition often goes underdiagnosed due to limited clinical awareness, absence of standardized screening tools, and inadequate postoperative surveillance. Consequently, preventable cases of cognitive dysfunction contribute to delayed recovery, increased healthcare expenditure, and diminished quality of life for surgical patients (9-11). Given its profound clinical implications, understanding the relationship between general anesthesia and postoperative delirium is crucial for enhancing perioperative care and patient safety. Identifying modifiable risk factors could enable clinicians to implement targeted preventive strategies, including careful titration of anesthetic depth, judicious use of sedatives and opioids, and vigilant monitoring of perioperative parameters (12). Therefore, the present study is designed to evaluate the effects of general anesthesia on postoperative delirium among surgical patients at District Headquarters (DHQ) Hospital, Lakki Marwat. The primary objective is to determine the frequency of postoperative delirium and identify associated demographic, clinical, and anesthetic factors, thereby providing evidence to guide preventive interventions and improve surgical outcomes.

METHODS

The present study employed a hospital-based descriptive cross-sectional design to evaluate the effects of general anesthesia on the development of postoperative delirium among surgical patients. This design was considered appropriate for determining the frequency and associated factors of delirium within a defined hospital population at a single point in time. The research was carried out at the District Headquarters (DHQ) Hospital, Lakki Marwat, a secondary-level healthcare facility offering diverse surgical services, including general surgery, orthopedics, gynecology, and ENT procedures. The hospital's active anesthesia department and postoperative recovery units provided an optimal setting for observing anesthesia-related outcomes in a real-world clinical environment. The study population comprised adult patients undergoing various surgical procedures under general anesthesia at DHQ Hospital during the study period. Both elective and emergency cases were included to capture a representative sample of surgical patients. Inclusion criteria encompassed patients aged 18 years and above who underwent any surgical procedure under general anesthesia, were conscious and capable of postoperative cognitive assessment, and provided informed consent to participate. Exclusion criteria included individuals who received regional, spinal, or local anesthesia, patients with preexisting severe psychiatric illness or coma prior to surgery, and those with incomplete medical records or who were discharged or transferred before the 24-hour postoperative evaluation period.

A total of 177 patients were enrolled using a consecutive sampling technique, whereby every eligible patient meeting the inclusion criteria was recruited until the desired sample size was attained. The sample size was justified based on previous studies reporting a postoperative delirium prevalence of approximately 15–25%, which was considered statistically adequate to identify significant associations within the available population. Data collection was conducted over a predetermined period following ethical approval

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

obtained from the Institutional Review Committee of DHQ Hospital, Lakki Marwat. Permission to conduct the study was also secured from the hospital administration. Eligible patients scheduled for surgery were identified through the operation theatre lists. The study objectives were explained clearly to each participant, and written informed consent was obtained either directly or from an attendant when the patient was unable to provide consent. Data were collected using a structured proforma designed to ensure completeness, uniformity, and accuracy throughout all stages of the study. The data collection process was divided into preoperative, intraoperative, and postoperative phases. In the preoperative phase, demographic and clinical information was recorded through patient interviews and review of medical records. Variables included age, gender, educational status, and residence, along with clinical details such as comorbidities, American Society of Anesthesiologists (ASA) physical status classification, and baseline cognitive function. Baseline cognitive status was assessed using simple orientation and memory-based screening questions to rule out preexisting cognitive impairment, ensuring that postoperative delirium could be reliably attributed to perioperative factors.

The intraoperative phase involved recording details such as type and duration of surgery, duration of anesthesia, administration of sedatives or opioids, and the presence of intraoperative hemodynamic instability. These parameters were documented by the attending anesthesia team. In the postoperative phase, patients were observed closely in the recovery room and surgical wards for a period of 24 to 72 hours following surgery. The presence of postoperative delirium was assessed using the Confusion Assessment Method (CAM), a standardized and validated diagnostic tool for identifying acute cognitive dysfunction. Postoperative outcomes, including the need for intensive care admission, complications, and duration of hospital stay, were also documented. To maintain data reliability, the researcher reviewed all forms daily for accuracy and consistency before analysis. All data were entered and analyzed using IBM SPSS Statistics, Version 25. Descriptive statistics were employed to summarize patient characteristics, including means and standard deviations for continuous variables and frequencies with percentages for categorical variables. Bivariate associations between independent factors and the occurrence of postoperative delirium were examined using the chi-square test. Variables demonstrating statistical significance ($p < 0.05$) were subsequently included in a binary logistic regression model to identify independent predictors of postoperative delirium. The strength of association was expressed as odds ratios (OR) with 95% confidence intervals (CI), and a p-value of less than 0.05 was considered statistically significant. Ethical principles of autonomy, confidentiality, and beneficence were upheld throughout the study. Patient anonymity was ensured by coding the data, and participation was voluntary, with the option to withdraw at any stage without consequences to treatment.

RESULTS

The study included 177 patients who underwent surgery under general anesthesia at DHQ Hospital, Lakki Marwat. Among them, 57.6% were male and 42.4% were female. The majority of participants were between 50 and 64 years of age (40.7%), followed by those aged 65 years or older (32.2%), with a mean age of 59.7 ± 12.8 years. Over half of the patients (53.7%) were classified as ASA I–II, while 46.3% belonged to the higher-risk ASA III–IV category. Elective procedures accounted for 67.8% of surgeries, and 32.2% were performed on an emergency basis. The duration of anesthesia ranged from 0.8 to 6 hours, with an average of 2.9 ± 1.3 hours; 44.1% of surgeries lasted 2–4 hours, and 17.5% exceeded 4 hours. Preexisting cognitive impairment was documented in 14.1% of cases, while 62.1% of patients had one or more comorbidities. Intraoperative opioid exposure was high in 30.5% of patients, and 22.6% required postoperative ICU admission. The overall incidence of postoperative delirium was 19.2%, reflecting a notable burden of this complication in patients receiving general anesthesia. Comparative analysis revealed that postoperative delirium was significantly more frequent among older adults aged 65 years and above, those with higher ASA classification (III–IV), individuals undergoing emergency procedures, and patients with prolonged anesthesia duration exceeding 4 hours ($p < 0.05$). Similarly, preexisting cognitive impairment, presence of comorbidities, and postoperative ICU admission were strongly associated with an increased likelihood of delirium ($p < 0.05$). No significant association was found between gender and delirium occurrence.

Descriptive evaluation of continuous parameters showed that the average hospital stay was 6.4 ± 2.5 days (ranging 2–15 days), and the mean intraoperative blood loss was 310 ± 145 mL, indicating moderate procedural invasiveness and variable recovery durations. Multivariate binary logistic regression identified several independent predictors of postoperative delirium. Patients aged 65 years or older were 2.61 times more likely to develop delirium compared to younger individuals (OR = 2.61, 95% CI: 1.13–6.01, p = 0.026). Those with ASA class III–IV had 2.42 times higher odds (OR = 2.42, 95% CI: 1.10–5.34, p = 0.028), while undergoing emergency surgery doubled the risk (OR = 2.31, 95% CI: 1.09–4.88, p = 0.029). Anesthesia duration exceeding four hours tripled the likelihood of delirium (OR = 3.43, 95% CI: 1.36–8.67, p = 0.009). Preexisting cognitive impairment emerged as the strongest predictor, increasing

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

the risk more than fourfold (OR = 4.32, 95% CI: 1.52–12.29, p = 0.006). The regression model showed a good fit (Nagelkerke R^2 = 0.41) and an overall classification accuracy of 84.2%, suggesting a strong predictive validity of the included variables.

Table 1: Sample Characteristics (n = 177)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	102	57.6
	Female	75	42.4
Age group	< 50 years	48	27.1
	50–64 years	72	40.7
	≥ 65 years	57	32.2
ASA class	I–II	95	53.7
	III–IV	82	46.3
Type of surgery	Elective	120	67.8
	Emergency	57	32.2
Anesthesia duration	< 2 hours	68	38.4
	2–4 hours	78	44.1
	> 4 hours	31	17.5
Preexisting cognitive impairment	Yes	25	14.1
	No	152	85.9
Comorbidity (≥1)	Yes	110	62.1
	No	67	37.9
Intra-op opioid exposure	High dose	54	30.5
	Low/None	123	69.5
Post-op ICU admission	Yes	40	22.6
	No	137	77.4
Postoperative delirium (outcome)	Yes	34	19.2
	No	143	80.8

Table 2: Postoperative Delirium by Patient Characteristics

Variable	Category	Delirium Present (n = 34)	No Delirium (n = 143)	p-value*
Gender	Male	18 (52.9 %)	84 (58.7 %)	0.54
	Female	16 (47.1 %)	59 (41.3 %)	
Age group	< 50 yrs	4 (11.8 %)	44 (30.8 %)	0.03

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

Variable	Category	Delirium Present (n = 34)	No Delirium (n = 143)	p-value*
	50–64 yrs	13 (38.2 %)	59 (41.3 %)	
	≥ 65 yrs	17 (50.0 %)	40 (28.0 %)	
ASA class	I–II	11 (32.4 %)	84 (58.7 %)	0.01
	III–IV	23 (67.6 %)	59 (41.3 %)	
Type of surgery	Elective	17 (50.0 %)	103 (72.0 %)	0.02
	Emergency	17 (50.0 %)	40 (28.0 %)	
Anesthesia duration	< 2 h	6 (17.6 %)	62 (43.4 %)	0.004
	2–4 h	15 (44.1 %)	63 (44.1 %)	
	> 4 h	13 (38.3 %)	18 (12.6 %)	
Preexisting cognitive impairment	Yes	11 (32.4 %)	14 (9.8 %)	0.002
	No	23 (67.6 %)	129 (90.2 %)	
Comorbidity (≥ 1)	Yes	27 (79.4 %)	83 (58.0 %)	0.03
	No	7 (20.6 %)	60 (42.0 %)	
Post-op ICU admission	Yes	13 (38.2 %)	27 (18.9 %)	0.03
	No	21 (61.8 %)	116 (81.1 %)	

Table 3: Descriptive Statistics of Continuous Variables

Variable	Mean ± SD	Minimum	Maximum
Age (years)	59.7 ± 12.8	25	84
Duration of anesthesia (hours)	2.9 ± 1.3	0.8	6.0
Hospital stay (days)	6.4 ± 2.5	2	15
Intra-operative blood loss (mL)	310 ± 145	100	900

Table 4: Binary Logistic Regression Analysis Predicting Postoperative Delirium (n = 177)

Predictor Variable	B (β coefficient)	SE	Wald χ^2	p-value	Adjusted OR	95 % CI for OR
Age ≥ 65 yrs	0.96	0.43	4.97	0.026	2.61	1.13 – 6.01
ASA III–IV	0.88	0.40	4.86	0.028	2.42	1.10 – 5.34
Emergency surgery	0.84	0.38	4.82	0.029	2.31	1.09 – 4.88
Anesthesia > 4 hours	1.23	0.47	6.83	0.009	3.43	1.36 – 8.67
Preexisting cognitive impairment	1.46	0.53	7.57	0.006	4.32	1.52 – 12.29
Constant	–3.28	0.75	—	0.001	—	—

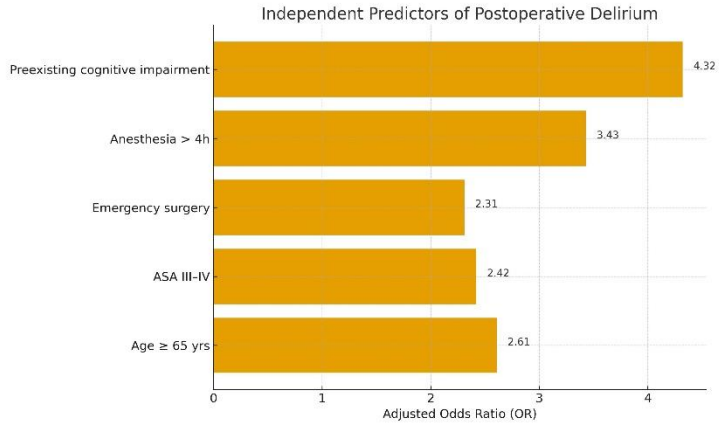

Figure 2 Independent Predictors of Postoperative Delirium

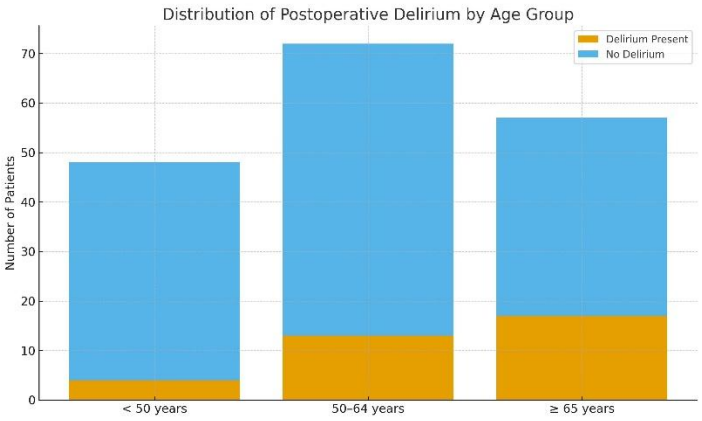

Figure 2 Distribution of Postoperative Delirium by Age Group

DISCUSSION

The present study investigated the effects of general anesthesia on the development of postoperative delirium (POD) and identified associated risk factors among surgical patients at a secondary care hospital. The findings demonstrated that postoperative delirium occurred in 19.2% of patients, a proportion aligning with previously reported global estimates ranging between 10% and 30% across various surgical populations. This consistency with international data reinforces the notion that delirium is a prevalent postoperative complication, even in regional hospital settings, and underscores the urgent need for systematic monitoring and prevention strategies in perioperative care. Aging emerged as one of the most influential predictors of postoperative delirium. Patients aged 65 years or older exhibited more than twice the likelihood of developing delirium compared to younger adults. The biological plausibility of this relationship is well established, as aging is accompanied by neurochemical alterations, diminished neuronal reserve, and an increased sensitivity to anesthetic and sedative agents, which collectively heighten susceptibility to postoperative cognitive disturbances (10–12). This study's findings corroborate prior research that consistently identifies advanced age as the most robust determinant of postoperative delirium across surgical contexts. Similarly, patients classified as ASA III–IV experienced higher rates of delirium, reflecting the compounded impact of systemic comorbidities and impaired physiological resilience on postoperative neurocognitive outcomes.

Emergency surgical procedures were also found to significantly increase the risk of postoperative delirium. Such cases typically involve inadequate preoperative optimization, hemodynamic instability, and rapid induction of anesthesia under stressful conditions, all of which amplify the neuroinflammatory and metabolic stress responses contributing to cognitive dysfunction. The observation that patients undergoing emergency operations faced almost double the risk compared to those in elective surgeries aligns with the consensus that surgical urgency and physiological stress serve as strong precipitating factors. Additionally, prolonged anesthesia duration beyond four hours markedly elevated delirium risk, supporting evidence that extended exposure to anesthetic agents may disrupt neurotransmitter homeostasis, impair cerebral oxygenation, and promote neuronal injury (13). Preexisting cognitive impairment was identified as the single most potent predictor, increasing the likelihood of postoperative delirium by more than fourfold. This finding substantiates prior conclusions that patients with baseline cognitive decline or dementia possess reduced neurophysiological adaptability to anesthesia and surgical stressors (14). The presence of comorbidities and postoperative ICU admission further strengthened the association with delirium, which may be attributed to higher illness severity, polypharmacy, and disturbed circadian rhythms. Similar associations have been established in other clinical settings, emphasizing that both biological vulnerability and environmental factors contribute to the pathogenesis of delirium (15–18). In contrast, no significant gender-based differences were observed, reaffirming that sex does not exert a notable influence on the incidence of postoperative cognitive complications.

The logistic regression model demonstrated satisfactory explanatory power (Nagelkerke $R^2 = 0.41$), suggesting that the selected variables accounted for a substantial portion of the variance in delirium occurrence. Nevertheless, this also implies that unmeasured factors such as the specific anesthetic drugs used, intraoperative hemodynamic fluctuations, and postoperative pain or sedative management may have contributed to the remaining variability (19,20). From a clinical standpoint, these findings underscore the necessity of a

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

multifactorial approach to prevention. Effective strategies should encompass preoperative optimization of comorbid conditions, avoidance of deep anesthesia and excessive sedative or opioid use, maintenance of hemodynamic stability, and continuous postoperative monitoring for early detection of cognitive changes. Routine screening using validated tools like the Confusion Assessment Method (CAM) can facilitate timely diagnosis and intervention, thereby reducing adverse outcomes (21). The study's strengths lie in its systematic assessment of perioperative variables, use of a validated delirium assessment tool, and comprehensive statistical modeling to identify independent predictors. Its implementation in a secondary-level hospital adds valuable regional data to a field dominated by tertiary-care research. However, several limitations must be acknowledged. The cross-sectional design limits causal inference, and variations in anesthetic techniques or surgical types were not controlled, which may have introduced confounding effects. Additionally, postoperative monitoring was limited to 72 hours, potentially missing cases of delayed-onset delirium. The cognitive screening prior to surgery was not standardized, which may have underestimated preexisting impairments. Despite these limitations, the study provides essential baseline data and highlights the urgent need for standardized delirium assessment protocols in local hospital systems. Overall, the findings reaffirm that postoperative delirium remains a multifactorial and preventable complication, particularly among elderly patients, those with higher ASA status, cognitive vulnerability, emergency surgical indications, and prolonged anesthesia exposure. The study contributes to the growing evidence advocating for integrated perioperative care that combines anesthetic precision, geriatric sensitivity, and proactive cognitive monitoring. Future research should focus on longitudinal and interventional designs to establish causal pathways, evaluate the role of anesthetic agents in neurocognitive outcomes, and develop cost-effective prevention programs suited to the resource constraints of regional healthcare settings (22).

CONCLUSION

This study concluded that general anesthesia plays a significant role in the development of postoperative delirium, particularly among elderly patients and those with existing comorbidities or prolonged surgical exposure. The findings emphasize that postoperative delirium is not solely a consequence of surgical stress but also a reflection of anesthetic and physiological factors that can be anticipated and mitigated through careful perioperative management. A comprehensive approach involving thorough preoperative evaluation, precise control of anesthetic depth, close intraoperative monitoring, and early postoperative cognitive assessment is essential to reduce delirium risk. By integrating preventive strategies and prioritizing cognitive well-being alongside physiological stability, anesthesia practice can substantially improve patient safety, recovery quality, and overall surgical outcomes.

AUTHOR CONTRIBUTION

Author	Contribution
Furqan Shah	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Hikmat Yar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Naseem Khan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Abdul Haleem	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Qasim Abbasi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

Author	Contribution
Anas Bacha Shaheen*	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

REFERENCES

1. Evered LA, Chan MTV, Han R, Chu MHM, Cheng BP, Scott DA, et al. Anaesthetic depth and delirium after major surgery: a randomised clinical trial. Br J Anaesth. 2021;127(5):704-12.

2. Yu L, Wang B, Huang L, Ni L. Analysis of contributing factors and nursing interventions for postoperative agitation following general anesthesia in thoracotomy patients. Medicine (Baltimore). 2024;103(37):e39580.

3. Ahrens E, Wachtendorf LJ, Shay D, Tenge T, Paschold BS, Rudolph MI, et al. Association Between Neuromuscular Blockade and Its Reversal With Postoperative Delirium in Older Patients: A Hospital Registry Study. Anesth Analg. 2025;141(2):363-72.

4. Reese M, Wright MC, Roberts KC, Browndyke JN, Bennett M, Acker L, et al. Associations between anaesthetic dose-adjusted intraoperative EEG alpha power, processing speed, and postoperative delirium: analysis of data from three prospective studies. Br J Anaesth. 2025;135(1):109-20.

5. Greco M, Calgaro G, Cavallo M, Pugliese S, Mascari M, Piccirillo F, et al. Brain-targeted goal-directed therapy in high-risk patients undergoing major elective surgery: Study protocol for the BRAIN-PROMISE randomized trial. Contemp Clin Trials. 2025;154:107940.

6. Kurup MT, Sarkar S, Verma R, Bhatia R, Khanna P, Maitra S, et al. Comparative evaluation of intraoperative dexmedetomidine versus lidocaine for reducing postoperative cognitive decline in the elderly: a prospective randomized controlled trial. Anaesthesiol Intensive Ther. 2023;55(5):349-57.

7. Bharadwaj S, Konar S, Akash VS, Gopalakrishna KN, Chakrabarti D, Kamath S. Emergence delirium after intracranial neurosurgery- a prospective cohort study. J Clin Neurosci. 2022;104:12-7.

8. Cai BY, He ST, Zhang Y, Ma JH, Mu DL, Wang DX. Impact of emergence delirium on long-term survival in older patients after major noncardiac surgery: A longitudinal prospective observational study. J Clin Anesth. 2024;99:111663.

9. Wittwer ED, Cerhan JH, Schroeder DR, Schaff HV, Mauermann WJ. Impact of ketamine versus propofol for anesthetic induction on cognitive dysfunction, delirium, and acute kidney injury following cardiac surgery in elderly, high-risk patients. Ann Card Anaesth. 2023;26(3):274-80.

10. Fang PP, Zhang HW, Hao XX, Shang ZX, Li J, Liu XS. Intraoperative electroencephalogram features related to frailty in older patients: an exploratory prospective observational study. J Clin Monit Comput. 2024;38(3):613-21.

11. Wesselink EM, Abawi M, Kooistra NHM, Kappen TH, Agostoni P, Emmelot-Vonk M, et al. Intraoperative hypotension and delirium among older adults undergoing transcatheter aortic valve replacement. J Am Geriatr Soc. 2021;69(11):3177-85.

12. Wang Y, Liu W, Chen K, Shen X. Postoperative Delirium is Not Associated with Long-Term Decline in Activities of Daily Living or Mortality After Laryngectomy. Clin Interv Aging. 2021;16:823-31.

13. Yaguchi T, Ichinokawa H, Kirino E, Suzuki M, Komori K, Matsunaga T, et al. Predictive factors for postoperative delirium in thoracic surgery. Gen Thorac Cardiovasc Surg. 2024;72(9):599-607.

14. Farrer TJ, Monk TG, McDonagh DL, Martin G, Pieper CF, Koltai D. A prospective randomized study examining the impact of intravenous versus inhalational anesthesia on postoperative cognitive decline and delirium. Appl Neuropsychol Adult. 2025;32(4):1155-61.

15. Li X, Lai H, Wang P, Feng S, Feng X, Kong C, et al. Risk Factors for Postoperative Cognitive Decline After Orthopedic Surgery in Elderly Chinese Patients: A Retrospective Cohort Study. Clin Interv Aging. 2024;19:491-502.

16. Cahuich-Rodríguez BA, Acosta-Mass AG, Rocha-González HI. [Risk of postoperative delirium in older adults under balanced general anesthesia]. Rev Med Inst Mex Seguro Soc. 2024;62(6):1-8.

17. Li T, Dong T, Cui Y, Meng X, Dai Z. Effect of regional anesthesia on the postoperative delirium: a systematic review and meta-analysis of randomized controlled trials. Front Surg. 2022;9:937293.

18. Zhuang X, He Y, Liu Y, Li J, Ma W. The effects of anesthesia methods and anesthetics on postoperative delirium in elderly patients: a systematic review and network meta-analysis. Front Aging Neurosci. 2022;14:935716.

19. Wang Y, Zhu H, Xu F, Ding Y, Zhao S, Chen X. The effect of anesthetic depth on postoperative delirium in older adults: a systematic review and meta-analysis. BMC Geriatr. 2023;23(1):719.

20. Fathy W, Hussein M, Elanwar R, Elmoutaz H, Abdelsadek DA, Kassim DY. Effect of intra-operative magnesium sulphate on the occurrence of postoperative delirium and insomnia in patients undergoing lumbar fixation: a randomized controlled trial. BMC Anesthesiol. 2024;24(1):289.

21. Bălășescu I, Torsin LI, Hostiuc L, Nitipir C, Corneci D, Dutu M. The surgical stress response and anesthesia: a narrative review. J Clin Med. 2024;13(10):3017.

22. Dunn R, Cao L, Zhang H, Li P, Wu X, Li J. The effect of fascia iliaca compartment block on postoperative delirium in elder adults undergoing hip surgery: a systematic review and meta-analysis of randomized controlled trials. Int J Orthop Trauma Nurs. 2024;101122.