

POSTOPERATIVE COGNITIVE FUNCTION IN GERIATRIC PATIENTS UNDERGOING SURGERY WITH GENERAL ANESTHESIA AT THE CENTRAL OPERATING THEATRE OF PROF. DR. I.G.N.G. NGOERAH GENERAL HOSPITAL, DENPASAR

Patricia Orlyn Jotan¹, I Gusti Agung Gede Utara Hartawan², Made Septyana Parama Adi², Dewa Ayu Mas Shintya Dewi²

¹. Bachelor of Medicine, Faculty of Medicine, Udayana University

². Department of Anesthesiology, Udayana University

***Correspondence author:**

Patricia Orlyn Jotan

Bachelor of Medicine, Faculty of Medicine, Udayana University

E-mail: orlynjotan@gmail.com

ABSTRACT

Introduction: Postoperative cognitive dysfunction (POCD) is a common complication in geriatric patients following surgery under general anesthesia and may negatively affect quality of life and functional independence. This study aimed to describe the cognitive function of geriatric patients 24 hours after undergoing surgery with general anesthesia at Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar.

Methods: This study was a descriptive observational study with a cross-sectional design. Geriatric patients aged ≥ 60 years who underwent surgery under general anesthesia between March and October 2025 were included using consecutive sampling. Cognitive function was assessed 24 hours postoperatively using the Mini-Mental State Examination (MMSE). Data were analyzed descriptively and presented as frequencies and percentages.

Results: A total of 88 patients were included, with the majority being female (51.1%) and aged 60–69 years (55.7%). Based on MMSE scores, 67 patients (76.1%) had normal cognitive function, 16 patients (18.2%) had probable cognitive impairment, and 5 patients (5.7%) had definite cognitive impairment. Normal cognitive function was more frequently observed in patients with higher educational levels and higher occupational complexity. A greater proportion of definite cognitive impairment was found in patients with anesthesia duration longer than four hours.

Conclusion: Most geriatric patients maintained normal cognitive function 24 hours after surgery with general anesthesia; however, nearly one-quarter experienced postoperative cognitive impairment. These findings highlight the importance of early cognitive assessment and monitoring in geriatric surgical patients.

Keywords: cognitive function, geriatrics, general anesthesia, MMSE, postoperative

INTRODUCTION

Aging is a natural process associated with gradual physiological changes, including a decline in cognitive function. Cognitive function refers to the ability to think, learn, and remember clearly and plays a critical role in daily activities. It comprises several domains such as attention, orientation, memory, language, and visuospatial abilities. Although cognitive decline is considered part of normal aging, its onset and progression vary among individuals and may be influenced by genetic, lifestyle, and environmental factors^{1,2}.

Evidence indicated that cognitive abilities declined progressively with age, particularly in domains requiring processing speed, working memory, and executive functions. Longitudinal studies have shown that some cognitive domains

begin to decline in midlife, with measurable reductions in processing speed and memory performance detectable in adults from their 40s into later adulthood^{3,4}.

The demand for surgical procedures increases with advancing age. More than one-third of surgeries are performed in individuals aged 65 years and older, and this proportion continues to rise globally. Most surgical procedures require anesthesia, particularly general anesthesia for major operations. While general anesthesia is essential for surgical care, it may adversely affect cognitive function, especially in older adults with reduced cognitive reserve^{5,6}. Emerging evidence suggested that general and regional anesthesia may differentially affect postoperative cognitive outcomes, potentially through mechanisms involving

neuroinflammation and disruptions to blood-brain barrier integrity⁷.

Geriatric patients are at increased risk of postoperative neurocognitive complications, particularly postoperative delirium and postoperative cognitive dysfunction (POCD). POCD is characterized by persistent impairments in memory, attention, and executive function following surgery. Reported incidence rates of POCD vary widely, ranging from 10% to 35%, depending on patient characteristics, type of surgery, and anesthetic technique. Advanced age, comorbidities, and general anesthesia have been identified as significant risk factors⁸⁻¹⁰. In a prospective study of elderly surgical patients, approximately 28.5% developed POCD within one week after major elective surgery, indicating a substantial incidence in geriatric populations¹¹.

In Indonesia and globally, postoperative cognitive dysfunction (POCD) after non-cardiac, non-neurological surgery was reported to occur frequently in older adults, and some studies suggested that general anesthesia was associated with a tendency toward higher early postoperative cognitive decline compared with regional anesthesia. POCD was also associated with delayed recovery, impaired quality of life, and increased dependency after surgery¹²⁻¹⁴.

Given the increasing number of elderly patients undergoing surgery and the significant impact of POCD, understanding postoperative cognitive outcomes is essential. Therefore, this study aims to describe cognitive function in geriatric patients after surgery under general anesthesia at RSUP Prof. Dr. I.G.N.G. Ngoerah Denpasar.

MATERIAL AND METHOD

This study was a descriptive observational study with a cross-sectional design. The study was conducted at the Central Surgical Installation of Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, a tertiary referral hospital in Bali, Indonesia, from March to October 2025.

The study population consisted of geriatric patients who underwent surgical procedures under general anesthesia at the Central Surgical Installation of Prof. Dr. I.G.N.G. Ngoerah

General Hospital, Denpasar. The study sample comprised geriatric patients who met the inclusion and exclusion criteria. Actual study subjects were patients who agreed to participate in the study and provided written informed consent prior to data collection.

The inclusion criteria were as follows: (1) geriatric patients scheduled to undergo surgery with general anesthesia at the Central Surgical Installation of Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar; (2) age ≥ 60 years; (3) patients who were able to communicate effectively and complete the Mini-Mental State Examination (MMSE) questionnaire; (4) patients who had completed 24 hours following surgery and general anesthesia; and (5) patients who voluntarily agreed to participate in the study.

Patients were excluded if they refused to participate or had pre-existing cognitive disorders that could interfere with cognitive assessment, such as dementia (including Alzheimer's disease), delirium, or other severe neurocognitive disorders.

Sampling was performed using a consecutive sampling technique, whereby all eligible patients who met the inclusion criteria during the study period were recruited until the required sample size was achieved.

Data collection was conducted through direct interviews using a structured questionnaire. Sociodemographic data and clinical characteristics were obtained through patient interviews and review of medical records. Cognitive function was assessed 24 hours postoperatively through face-to-face interviews using the Mini-Mental State Examination (MMSE) questionnaire, administered by the researcher. MMSE scores were categorized into normal cognitive function, probable cognitive impairment, and definite cognitive impairment according to established scoring criteria. Data were analyzed descriptively using SPSS version 27. Categorical variables were presented as frequencies and percentages.

This study was approved by the Ethics Committee of the Faculty of Medicine, Udayana University. All participants provided written informed consent prior to participation, and confidentiality of patient data was strictly maintained.

RESULTS

Table 1. General Characteristics of Study Participants

Characteristics	Total n (%)
Sex	
- Female	45 (51,1)
- Male	43 (48,9)
Age	
- 60–69 years old	49 (55,7)
- 70–79 years old	37 (42)
- ≥ 80 years old	2 (2,3)
Level of education	
- Low	37 (42)
- Moderate	26 (29,5)
- High	25 (28,4)

Occupation	
- Low	27 (30,7)
- Moderate	42 (47,7)
- High	19 (21,6)
Anesthesia duration	
- ≤ 2 hour	27 (30,7)
- > 2 – ≤ 4 hour	55 (62,5)
- > 4 – ≤ 6 hour	6 (6,8)
Medical History	
- Stroke	3 (3,4)
- Diabetes Mellitus	10 (11,4)
- Heart Disease	8 (9,1)
- SLE	0 (0)
- Hipertension	18 (20,5)
- Others	7 (8)

A total of 88 geriatric patients who underwent surgery with general anesthesia were included in this study. The majority of participants were female (51.1%), while males accounted for 48.9%. Most respondents were aged 60–69 years (55.7%), followed by those aged 70–79 years (42.0%) and ≥80 years (2.3%).

Regarding educational background, 42.0% of participants had a low level of education, 29.5% had a moderate level, and 28.4% had a high level of education. Based on occupational history, most participants had moderate occupational complexity

(47.7%), followed by low (30.7%) and high occupational complexity (21.6%).

In terms of perioperative characteristics, most patients underwent anesthesia for more than 2 to ≤4 hours (62.5%), followed by ≤2 hours (30.7%) and >4 to ≤6 hours (6.8%). Regarding medical history, hypertension was the most common comorbidity (20.5%), followed by diabetes mellitus (11.4%) and heart disease (9.1%). Other medical conditions were present in smaller proportions.

Table 2. Overall Cognitive Function Based on MMSE Scores

MMSE	Total n (%)
Normal	67 (76,1)
Probable cognitive impairment	16 (18,2)
Definite cognitive impairment	5 (5,7)

Assessment of cognitive function using the Mini-Mental State Examination (MMSE) 24 hours after surgery showed that 67 patients (76.1%) had normal cognitive function. Probable

cognitive impairment was identified in 16 patients (18.2%), while 5 patients (5.7%) were classified as having definite cognitive impairment.

Table 3. Cognitive Function Based on Sociodemographic and Clinical Characteristics

Characteristics	MMSE		
	Normal	Probable CI	Definite CI
Sex			
- Female	35 (77,8)	7 (15,6)	3 (6,7)
- Male	32 (74,4)	9 (20,9)	2 (4,7)
Age			
- 60–69 years old	33 (67,3)	11 (2,4)	5 (10,2)
- 70–79 years old	32 (86,5)	5 (13,5)	0 (0)
- ≥80 years old	2 (100)	0 (0)	0 (0)
Level of education			
- Low	23 (62,2)	10 (27)	4 (10,8)
- Moderate	21 (80,8)	4 (15,4)	1 (3,8)
- High	23 (92)	2 (8)	0 (0)

Occupation			
- Low	21 (77,8)	6 (22,2)	0 (0)
- Moderate	29 (69)	9 (21,4)	4 (9,5)
- High	17 (89,5)	1 (5,3)	1 (5,3)
Anesthesia duration			
- ≤ 2 hour	16 (59,3)	9 (33,3)	2 (7,4)
- > 2 – ≤ 4 hour	47 (85,5)	6 (10,9)	2 (3,6)
- > 4 – ≤ 6 hour	4 (66,7)	1 (16,7)	1 (16,7)
Medical History			
- Stroke	3 (100)	0 (0)	0 (0)
- Diabetes Mellitus	8 (80)	1 (10)	1 (10)
- Heart Disease	8 (100)	0 (0)	0 (0)
- SLE	0 (0)	0 (0)	0 (0)
- Hipertension	17 (94,4)	0 (0)	1 (5,6)
- Others	4 (57,1)	2 (28,8)	1 (14,3)

CI : Cognitive Impairment

When cognitive function was analyzed according to sex, normal MMSE scores were observed in 77.8% of female patients and 74.4% of male patients. Probable cognitive impairment was slightly more frequent among male patients, whereas definite cognitive impairment was more frequently observed among female patients.

Based on age group, normal cognitive function was most commonly found in patients aged 70–79 years (86.5%), while definite cognitive impairment was only observed in patients aged 60–69 years and ≥80 years. All patients aged ≥80 years demonstrated normal cognitive function.

With respect to educational level, normal cognitive function was more frequently observed in patients with higher educational attainment. Definite cognitive impairment was only found among patients with low to moderate levels of education, whereas no cases of definite impairment were observed in patients with high educational levels.

According to occupational complexity, patients with high-complexity occupations demonstrated the highest proportion of normal cognitive function. Definite cognitive impairment was more frequently observed among patients with moderate occupational complexity.

When analyzed based on anesthesia duration, definite cognitive impairment was more frequently observed in patients who underwent anesthesia for more than four hours compared to those with shorter anesthesia duration.

Regarding medical history, cognitive impairment was more commonly identified among patients with hypertension and diabetes mellitus. Patients with a history of stroke, heart disease, or systemic lupus erythematosus predominantly demonstrated normal cognitive function.

DISCUSSION

Cognitive Function Profile

The results of this study demonstrated that the majority of geriatric patients (76.1%) maintained normal cognitive function based on MMSE scores 24 hours after surgery, while 23.9% experienced cognitive impairment ranging from probable to

definite impairment. This finding is consistent with recent studies reporting the incidence of postoperative cognitive dysfunction (POCD) in elderly patients to range between 18% and 32% within the first postoperative week¹⁵. Variations in reported incidence across studies may be attributed to differences in patient characteristics, types of surgery, anesthetic techniques, and the cognitive screening instruments used.

Cognitive Function According to Sex

In this study, the proportion of cognitive impairment was slightly higher among male patients compared to female patients. Normal cognitive function was more frequently observed in female patients (77.8%) than in male patients (74.4%). Probable cognitive impairment was identified in 15.6% of female patients and 20.9% of male patients, while definite cognitive impairment was found in 6.7% of female patients and 4.7% of male patients. Overall, these findings suggest that sex is unlikely to be a strong independent risk factor for the development of POCD.

This observation aligns with previous literature indicating that sex does not consistently emerge as an independent predictor of POCD after adjustment for other contributing factors¹⁰. However, contrasting evidence has been reported in other studies, which identified female sex as a significant risk factor for POCD in older age groups¹³. This increased vulnerability in females has been attributed to postmenopausal estrogen deficiency, which may promote central obesity and metabolic syndrome. These conditions have been associated with age-related cognitive impairment and dementia in women¹⁶. Nonetheless, further studies are required to clarify the role of sex in POCD development.

Cognitive Function According to Educational Level

The present study found that normal cognitive function was most prevalent among patients with high educational attainment (92.0%), followed by those with moderate education (80.8%), and was lowest among patients with low educational levels (62.2%). Conversely, cognitive impairment was most frequently observed in the low education group. These findings are consistent with the concept of cognitive reserve, which posits that higher educational attainment strengthens neural reserve and reduces susceptibility to postoperative cognitive decline.

Previous studies have reported that individuals with higher education possess greater brain reserve capacity, enabling better tolerance to perioperative neurological insults¹⁷. To date, there is limited evidence contradicting this association, further supporting the protective role of education against POCD.

Cognitive Function According to Occupational Complexity

Patients with high occupational complexity demonstrated the highest proportion of normal cognitive function (89.5%), while those with moderate occupational complexity showed the lowest proportion (69.0%). Patients with low occupational complexity exhibited intermediate outcomes. This pattern suggests that occupations with greater cognitive demands may be associated with better postoperative cognitive performance.

These findings are consistent with the cognitive reserve hypothesis, whereby cognitively stimulating occupations contribute to enhanced neural resilience against the effects of surgery and anesthesia. Existing literature supports this association, indicating that mentally demanding occupations may increase cognitive reserve in a manner similar to higher educational attainment^{17,18}. Currently, there is no substantial evidence refuting this relationship.

Cognitive Function According to Age

Contrary to conventional expectations, patients aged 60–69 years exhibited the lowest proportion of normal cognitive function (67.3%) and the highest proportion of definite cognitive impairment (10.2%), whereas patients aged 70–79 years and ≥80 years demonstrated higher proportions of normal cognitive function. This finding contrasts with extensive literature indicating that the incidence of POCD increases with advancing age¹⁷. For instance, previous studies reported that approximately 40% of elderly patients developed POCD after surgery, with cognitive decline persisting through early follow-up¹⁹.

The unexpected pattern observed in this study is likely attributable to the limited sample size in the older age groups, particularly among patients aged ≥80 years. Selection bias and individual variability among patients who met the inclusion criteria may have contributed to an overrepresentation of cognitively intact individuals in these age categories.

Cognitive Function According to Anesthesia Duration

Patients who underwent anesthesia for ≤2 hours exhibited the lowest proportion of normal cognitive function (59.3%), whereas those with anesthesia duration of >2–4 hours demonstrated the highest proportion of normal cognitive function (85.5%). In contrast, patients with the longest anesthesia duration (>4–6 hours) showed an increased proportion of definite cognitive impairment (16.7%).

These findings partially align with existing literature suggesting that prolonged anesthesia duration is associated with an increased risk of POCD. Reduced drug elimination in elderly patients may result in prolonged exposure to anesthetic agents, thereby increasing the likelihood of cognitive impairment. Multivariate analyses in previous studies have identified longer anesthesia duration as an independent risk factor for POCD, as it often reflects more complex surgical procedures, greater tissue

trauma, and extended exposure to anesthetic agents. These factors may contribute to neuroinflammation, alterations in amyloid and tau proteins, cerebral hypoperfusion, and neurotoxic effects on neurons and synapses¹⁵.

Differences between the present findings and previous studies might be influenced by variations in surgical procedures and anesthetic management, including duration of anesthesia and type of surgery¹⁴.

Cognitive Function According to Medical History

In this study, the majority of participants did not have severe comorbidities. Among patients with comorbid conditions, all patients with a history of stroke or heart disease demonstrated normal cognitive function. Most patients with diabetes mellitus exhibited normal cognitive function (80.0%), while patients with hypertension showed a high proportion of normal cognitive function (94.4%) with a small proportion experiencing definite cognitive impairment (5.6%). Overall, the presence of comorbidities did not demonstrate a consistent direct association with cognitive impairment in this sample.

Nevertheless, existing literature has identified diabetes mellitus and hypertension as important risk factors for POCD. Meta-analyses have reported that patients with diabetes have a significantly increased risk of developing POCD. Chronic hypertension may impair cerebral autoregulation, rendering the brain more vulnerable to perioperative perfusion fluctuations. Reduced cerebral perfusion, particularly in the presence of intraoperative hypotension, may lead to ischemia, oxidative stress, and neurotransmitter dysfunction, ultimately contributing to postoperative cognitive decline^{15,20}.

In the present study, the relatively low proportion of cognitive impairment among patients with diabetes mellitus and hypertension may be attributable to the limited sample size. Other potential risk factors, such as prior stroke or heart disease, were not clearly identified, likely due to low prevalence within the study population. Additionally, systemic lupus erythematosus was not observed among participants, precluding further analysis. These findings highlight the need for future studies with larger sample sizes and more diverse patient characteristics to comprehensively evaluate risk factors associated with POCD.

STUDY LIMITATION

Several limitations of this study should be acknowledged. First, the descriptive cross-sectional design precludes causal inference between potential risk factors and postoperative cognitive dysfunction. Second, the sample size was relatively limited, particularly in certain subgroups such as patients aged ≥80 years and those with specific comorbidities, which may have influenced the distribution of cognitive outcomes. Third, cognitive assessment was conducted only once, at 24 hours postoperatively, and therefore may not capture delayed or persistent cognitive changes. Additionally, the Mini-Mental State Examination (MMSE), while widely used, has limited sensitivity for detecting subtle cognitive impairment and may be influenced by educational background.

CONCLUSION AND RECOMMENDATION

This study demonstrated that the majority of geriatric patients maintained normal cognitive function 24 hours after undergoing surgery with general anesthesia. However, nearly one-quarter of patients experienced postoperative cognitive impairment, ranging from probable to definite impairment. Cognitive outcomes varied according to educational level, occupational complexity, age group, duration of anesthesia, and the presence of certain comorbidities. These findings underscore the importance of early identification and monitoring of cognitive function in geriatric patients undergoing surgical procedures.

Routine preoperative and postoperative cognitive screening using standardized assessment tools is recommended for geriatric patients, particularly those with lower educational attainment, lower occupational complexity, prolonged anesthesia duration, or comorbid conditions such as diabetes mellitus and hypertension. Clinicians should consider these factors in perioperative planning to minimize the risk of postoperative cognitive dysfunction.

Future studies are recommended to employ longitudinal and analytical designs with larger and more diverse sample populations to identify independent risk factors, clarify underlying mechanisms, and evaluate effective preventive and therapeutic strategies for postoperative cognitive dysfunction in the geriatric population.

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