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Early postoperative cognitive dysfunction and its association with 1-year mortality in older surgical patients: a prospective cohort study

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Article

Keywords: Anesthesia, Geriatric, Long-term mortality, Major surgery, Postoperative cognitive dysfunction

Posted Date: August 4th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9987608/v1

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Additional Declarations: No competing interests reported.

Abstract

Postoperative cognitive dysfunction (POCD) commonly occurs within the first postoperative week, but data on its impact on 1-year outcomes remain limited. We aimed to determine the incidence of 1-year mortality among older surgical patients and whether POCD at 1 week is associated with it. We conducted a prospective cohort study at a university hospital, enrolling patients ≥ 60 years undergoing moderate to major surgery. Cognitive function was assessed preoperatively and within 1 week postoperatively using the Montreal Cognitive Assessment, and mortality was evaluated at 1 year. The incidence of 1-year mortality was 5.7% (29/508), and POCD at 1 week, defined as a ≥ 2-point decline from baseline, occurred in 126 patients (24.8%). In multivariable Cox regression, factors independently associated with 1-year mortality were POCD (adjusted hazard ratio [aHR], 2.72; 95% CI, 1.27–5.84; *P* = 0.003), chronic kidney disease stage 4–5 (aHR, 3.11; 95% CI, 1.33–7.27; *P* = 0.009), cancer (aHR, 4.27; 95% CI, 1.97–9.25; *P* < 0.001), and age ≥ 70 years (aHR, 2.66; 95% CI, 1.01–7.04; *P* = 0.049). Early POCD was independently associated with increased 1-year mortality. These findings suggest early identification and prevention of POCD may improve postoperative outcomes and reduce long-term mortality.

Introduction

The global population is aging rapidly, and Thailand is no exception, transitioning into a super-aged society with a projected 18.2 million older adults in early 2026[1]. Rising life expectancy and advances in surgical and anesthetic techniques mean that a growing number of older adults now undergo surgery[2]. Although surgery can improve survival and quality of life, older patients remain particularly vulnerable to postoperative complications because of age-related physiological decline[3, 4], multimorbidity,[5] and frailty[6]. One-year mortality is therefore a particular concern in this population[7, 8].

Surgery acts as a physiological stressor that accelerates health decline in vulnerable older adults. Several studies have reported 1-year postoperative mortality of 5.9% to 22.3% after both elective and non-elective surgery[7, 9, 10]. Among the complications noted above, postoperative neurocognitive disorders have emerged as a major concern in perioperative medicine[11]. Postoperative cognitive dysfunction (POCD) is characterized by a decline in cognitive performance after surgery[12], affecting domains such as memory, attention, executive function, and language. Unlike postoperative delirium, which presents as an acute, fluctuating disturbance of consciousness and attention[13], POCD is often subtle and may be detected only through formal neuropsychological testing[14].

Reported incidence rates of POCD range from 23% to 41%[15, 16]. Early POCD typically arises within days to weeks after surgery; it may resolve within days or persist for 3 months to 7.5 years[17]. Previous studies have shown that early POCD is associated with adverse outcomes[18], including prolonged hospital stay, delayed functional recovery, reduced quality of life, and increased healthcare utilization[19]. Early POCD has also been linked to increased mortality and to a higher risk of premature occupational withdrawal[20].

Several studies have examined early postoperative cognitive decline and its relationship with mortality at 90 or 180 days, whereas data on 1-year mortality remain sparse[21–23]. In particular, a seminal study by Monk et al[24] reported that POCD persisting at hospital discharge and at 3 months was associated with increased 1-year mortality after major non-cardiac surgery. However, evidence on the long-term impact of early POCD in older adults remains limited, especially in Asian populations undergoing a wide range of moderate to major surgical procedures.

The primary objective of this prospective cohort study was to determine the incidence of 1-year mortality among older patients undergoing moderate to major surgery at a single university hospital in Thailand. The secondary objectives were to evaluate the association between POCD at 1 week and 1-year mortality. We also examined specific Montreal Cognitive Assessment (MoCA) domains and their relationship with 1-year mortality among patients with POCD in our cohort.

Methods

Study design

This prospective cohort study was conducted at a university hospital and approved by the Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University. It was performed in accordance with the ethical principles of the 1964 Declaration of Helsinki and its later amendments. All participants provided written informed consent.

Study population

The study population comprised patients aged 60 years or older scheduled for moderate or major surgery under anesthesia. Eligible procedures included cardiothoracic, neurological, hepatobiliary, colorectal, gynecological, urological, and orthopedic surgery. Patients were excluded if they could not complete the pre- and postoperative assessments. Reasons included an inability to communicate in Thai, severe auditory or visual impairment, or a diagnosed psychological disorder that could disrupt neurocognitive assessment.

Instruments

MoCA

Cognitive function was assessed before surgery and at 1 week after surgery using the MoCA[25]. The MoCA comprises 7 domains:

- visuospatial/executive function (trail making, cube copy, and clock drawing);
- naming (eg, lion, rhinoceros, camel);

- attention (digits forward and backward, target detection, and serial subtraction of 7);
- language (sentence repetition and verbal fluency);
- abstraction;
- delayed recall; and
- orientation.

MoCA scores range from 0 to 30, with scores ≥ 25 indicating normal cognition[26]. Assessments were performed at baseline 1 day before surgery, with follow-up evaluations at 1 week, 3 months, and 1 year after surgery.

Delirium screening

Postoperative delirium was evaluated with the Confusion Assessment Method (CAM)[27] or, in the intensive care unit, the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU)[28]. These tools were chosen for their high sensitivity and specificity and their familiarity in clinical practice. The instrument has 2 major criteria—acute onset or a fluctuating course, and inattention—and 2 minor criteria, namely an altered level of consciousness and disorganized thinking. Delirium was diagnosed when both major criteria and at least 1 minor criterion were present. Delirium was assessed for 3 days after surgery.

Data collection

All data were anonymized and labeled with unique research identification codes to ensure confidentiality. The data comprised:

- demographic data, such as age, sex, education level, and comorbidities;
- intraoperative and postoperative data, such as surgical site, anesthetic technique, anesthetic drugs, and postoperative complications; and
- long-term outcomes, assessed at 1 year after surgery.

One-year mortality data were obtained from, and verified by, the Bangkok Noi District Office. Medical experts and trained research assistants collected data prospectively from electronic medical records. Data were managed with REDCap (Research Electronic Data Capture), a web-based application designed for research data collection[29, 30].

Outcome assessments

The primary outcome was the incidence of 1-year mortality among older patients undergoing moderate to major surgery. The secondary outcome was the association between POCD at 1 week and 1-year

mortality. We also explored specific MoCA domains in patients with POCD and their relationship with 1-year mortality. In a study of a Thai population, the standard deviation of the MoCA score was 2.14[26]; a decrease of ≥ 2 points from baseline was therefore considered indicative of POCD.

Statistical analysis

The sample size was calculated from data reported by Monk et al[24], who observed a 5.5% 1-year mortality rate among 914 patients older than 18 years undergoing major non-cardiac surgery. Because the present study enrolled older patients undergoing moderate to major cardiac and non-cardiac surgery, 1-year mortality was estimated at approximately 9% (95% CI, 9% ± 2.5%). A total of 508 patients with a 1-week MoCA assessment was required. To allow for an 18% rate of missing 1-week MoCA assessments or cancelled surgery, the target sample was increased to 620 patients.

Patient characteristics and perioperative data were summarized using descriptive statistics—count (%), mean (SD), and median (IQR), as appropriate. Demographic and perioperative variables were compared between alive and dead patients using the unpaired *t* test for normally distributed quantitative variables and the Mann–Whitney *U* test for nonnormally distributed variables. Qualitative variables were compared using the Pearson χ^2 test and the Fisher exact test. Factors associated with survival within 1 year were assessed using a Cox proportional hazards model. Variables with a univariable *P* value < 0.20 were entered into the multivariable Cox regression model using the enter method. Results were reported as the adjusted hazard ratio, 95% CI, and *P* value. Changes in each MoCA domain between patients with POCD who survived and those who died were compared using the Mann–Whitney *U* test. Statistical analyses were performed using IBM SPSS Statistics version 30 (IBM Corp).

Results

Demographic data

Between December 2017 and September 2023, 650 patients aged ≥ 60 years undergoing moderate to major surgery under general or regional anesthesia were initially enrolled. Thirty patients withdrew consent. The remaining 620 patients provided informed consent and completed the preoperative assessment, of whom 112 were excluded for incomplete postoperative assessment. The final cohort therefore comprised 508 patients.

The mean age was approximately 71 years, and 350 patients (56.5%) were male. An underweight body mass index was recorded in 26 patients (5.1%) and was more frequent in patients who died than in those who survived (6/29 [20.7%] vs 20/479 [4.2%]; *P* < 0.001). Just over half of the patients (281/508, 55.3%) had completed more than 6 years of education. The most frequent comorbidities were hypertension (81.3%), dyslipidemia (70.1%), and cardiovascular disease (55.3%). Chronic kidney disease (CKD), cancer, cerebrovascular accident, and anemia showed statistically significant differences between survivors and non-survivors. The mean (SD) preoperative MoCA score was 19.17 (4.86; **Table 1**).

Perioperative data and outcomes

Intraoperative, postoperative, hospital-based, and long-term outcomes are shown in **Table 2**. Intrathoracic procedures accounted for 53.3% of surgeries; the remainder were gynecological, neurological, urological, orthopedic, hepatobiliary, general, and colorectal procedures. General anesthesia, alone or combined with other techniques, was used in 90.9% of cases. Benzodiazepines accounted for approximately one-third of anesthetic drugs administered (33.5%), and opioids were used in nearly all cases (99.8%).

Postoperative complications were recorded. Arrhythmia was the most common (24.8%), followed by postoperative delirium (18.1%) and acute kidney injury (15%). Nosocomial infections—pneumonia, wound infection, and urinary tract infection—occurred in 38 patients (7.5%). Nosocomial infection, airway obstruction, and cardiac arrest were more common in patients who died within 1 year than in survivors; these differences were statistically significant (**Table 2**). Almost half of the patients (48.4%) required postoperative ventilation.

The overall median length of stay was 8 days. Patients who died within 1 year tended to have a longer length of stay than survivors (11 vs 8 days; $P < 0.001$), with a median intensive care unit stay of 1 day. Two of the 508 patients (0.4%) experienced in-hospital mortality. The mean (SD) MoCA score at 1 week postoperatively was 19.51 (5.28), and the incidence of POCD at 1 week was 24.8%. The proportion with POCD was higher among patients who died within 1 year than among survivors (41.4% vs 23.8%; $P = 0.033$).

Factors associated with 1-year mortality

In the univariable and multivariable analyses, POCD, cancer, CKD stage 4–5, and age ≥ 70 years were independent risk factors for 1-year mortality in our cohort (**Table 3**). Anemia was statistically significant in the univariable analysis but not in the multivariable analysis. Underweight body mass index, cerebrovascular accident, nosocomial infection, airway obstruction, and cardiac arrest were statistically significant in the univariable analysis. Because of the small number of deaths, these variables were not entered into the multivariable model. Length of stay was longer in the group that died but, not being a direct cause of death, was also excluded from the multivariable model.

Cognitive domains and 1-year mortality

We analyzed the relationship between MoCA domain changes in patients with POCD and 1-year mortality (**Table 4**). A decline in the naming domain between the preoperative and postoperative assessments was associated with 1-year mortality (mean [SD], 0.04 [0.43] in survivors vs 0.67 [0.89] in non-survivors; $P < 0.001$).

Discussion

Incidence of 1-year mortality after moderate to major surgery

The incidence of 1-year mortality in our cohort was 5.7%, consistent with previous studies. Liew et al[10] and Monk et al[24] reported 1-year mortality rates of approximately 5% and 5.5%, respectively, among patients undergoing elective surgery. By contrast, mortality among older patients undergoing non-elective surgery was substantially higher, ranging from 15.3% to 31%[7, 8]. This difference highlights the impact of surgical urgency on postoperative outcomes, because non-elective procedures are often performed in patients with acute conditions, limited time for preoperative optimization, and higher perioperative risk. Surgical urgency is therefore an important factor associated with postoperative mortality.

Incidence of early POCD

The incidence of POCD at 1 week in our cohort was 24.8%, consistent with previous reports in older surgical populations[15]. The development of POCD is multifactorial and not fully understood. Several features of our cohort likely contributed to this incidence: the high proportion of patients aged ≥ 70 years (61.9%) and the generally low level of education. In addition, intrathoracic procedures predominated, and these carry a prominent risk of silent cerebral infarction[17]. The high comorbidity burden in our cohort may also have contributed. Moreover, the relatively low mean preoperative MoCA score suggests a vulnerable population with limited cognitive reserve.

POCD and 1-year mortality

Our principal finding is that early POCD was independently associated with 1-year mortality. Patients with POCD had more than a twofold higher risk of death at 1 year than those without POCD. A landmark study by Monk et al examined major non-cardiac surgery in patients ≥ 18 years[24]. Early and persistent POCD were associated with increased mortality at 3 months and at 1 year, respectively. Our study extends these findings to a contemporary Asian geriatric population undergoing both cardiac and non-cardiac moderate to major surgery, supporting POCD as a predictor of 1-year mortality.

Several mechanisms may explain the association between early POCD and 1-year mortality. First, POCD may reflect postoperative brain vulnerability, including hippocampal volume reduction[31], thalamic structural change[32], and reduced cerebral blood flow[33]. Older patients with subclinical neurodegeneration or cerebrovascular disease may be more susceptible to perioperative insults, such as neuroinflammation driven by changes in interleukin-6, a biomarker of several neuroinflammatory disorders[34, 35], and hypoperfusion[36].

Second, because POCD entails concurrent decline across multiple functional domains, its impact on clinical outcomes is multifactorial. POCD may impair patients' ability to adhere to treatment, participate

in rehabilitation, and perform self-care, leading to physical inactivity and greater dependence on others[37], thereby raising the risk of complications and mortality.

Importantly, in our multivariable model delirium was not independently associated with 1-year mortality, whereas POCD was. Although several studies have shown an association between delirium and POCD[38, 39], the two are distinct entities. Delirium is an acute, fluctuating disturbance of attention and awareness, whereas POCD reflects a more subtle but measurable cognitive decline. Our findings suggest that even subclinical cognitive changes detected by formal assessment may carry important long-term prognostic implications.

Other predictors of 1-year mortality

In addition to POCD, age ≥ 70 years, advanced CKD, and cancer were independently associated with 1-year mortality. These factors reflect the combined effect of frailty, comorbidity burden, and reduced physiological and cognitive reserve rather than the effect of any single factor. Frailty becomes more prevalent with age, so older patients are more vulnerable to surgical stress and poor outcomes[40].

Advanced CKD is associated with chronic inflammation[41] and cardiovascular disease[42] and often coexists with comorbidities such as diabetes mellitus or hypertension, reflecting broader metabolic disturbance. This pattern is consistent with previous studies suggesting that advanced CKD may increase the risk of postoperative long-term mortality[43, 44].

Cancer-related mortality is not unexpected in a cohort that included major oncologic procedures. Tumor biology—for example, aggressiveness and metastasis—may itself influence 1-year survival[45, 46]. Preoperative immune impairment and poor nutritional status, frequently observed in patients with cancer[47], may be reflected by anemia or hypoalbuminemia, both of which have been associated with increased mortality in hospitalized patients[48]. Although anemia was not independently associated with mortality after multivariable adjustment in our cohort, several studies support its association with 1-year mortality[49–51].

Cognitive domains involved in POCD and their association with 1-year mortality

Beyond the overall decline in global cognition, we examined which specific MoCA domains were associated with 1-year mortality among patients who developed POCD (Table 4). The MoCA evaluates 7 domains: visuospatial/executive function, naming, attention, language, abstraction, delayed recall, and orientation. Among these, the naming domain showed a statistically significant, greater decline between the preoperative and 1-week postoperative assessments in patients who died within 1 year than in survivors. The other domains showed no statistically significant difference between the 2 groups.

In previous studies, the precise pattern of cognitive change during the first 7 postoperative days remains unclear, with most reporting changes in attention, orientation, or visuospatial function[16, 52, 53]. The naming task traditionally uses 3 images of less common animals (lion, rhinoceros, camel) to assess

visual perception, semantic memory, abstract representation, and word retrieval[54]. Processing this multifaceted task requires frontal, temporal, and bilateral occipital networks[55]. The naming domain is also important for detecting cognitive decline in Lewy body dementia and Alzheimer disease[56]. Our findings suggest that failure of the naming network, which integrates temporal and frontal regions, may reflect an underlying neurodegenerative vulnerability.

Our domain-specific association with 1-year mortality should be interpreted with caution because of the relatively small number of deaths in the POCD subgroup. Larger studies are needed to confirm whether domain-specific cognitive changes add predictive value beyond overall POCD status.

Naming performance can also be influenced by educational level[57, 58] and cultural background. Nearly half of our patients had fewer than 6 years of education. Consistent with this, Hu et al found that 52.8% of their participants failed to identify the “rhinoceros” and “camel”, possibly reflecting limited familiarity with these animals. They therefore substituted the “tiger” and “panda”, which are indigenous to China, of medium frequency in Chinese, and readily identifiable in pictures[59]. In our cohort, no indigenous Thai animals were substituted for the original images in the naming task, which may have affected scoring.

In addition, although the MoCA is a useful screening tool for early neurocognitive decline[60], the sensitivity of its individual domains varies. Hendershott et al reported that the MoCA is particularly sensitive in detecting executive, visuospatial, and memory impairment, whereas other subsections show lower sensitivity and should be interpreted with caution[61]. This limitation in domain-specific evaluation may partly explain the variability we observed across MoCA domains.

Strengths and limitations

The strengths of this study include its prospective design, relatively large sample size, comprehensive perioperative data, and complete 1-year mortality follow-up. The use of standardized cognitive assessment tools—MoCA, CAM, and CAM-ICU—before and after surgery enhances the reliability of the POCD diagnosis. Notably, this is the first study to report the association between domain-specific changes in pre- and postoperative MoCA scores and 1-year mortality.

Several limitations should nonetheless be acknowledged. First, approximately 18% of enrolled patients did not complete the postoperative assessment, which may have biased our estimates of 1-year mortality and POCD incidence. Second, surgical procedures were not stratified into cardiac and non-cardiac surgery. Because mortality and POCD incidence may differ by surgical type[62], this may have introduced heterogeneity and influenced the observed 1-year mortality and its associated factors.

Third, although multivariable analysis was performed, residual confounding may remain, because the small number of events for some variables limited the number of risk factors that could be included. Fourth, POCD was defined as a ≥ 2-point decline in MoCA score; although pragmatic, this definition may differ from studies using z-score–based criteria. Fifth, the variability in surgical procedures may carry differing risks of mortality and POCD. Finally, as an observational study at a single tertiary center, this work cannot establish causality, and its generalizability may be limited.

Clinical implications

This study has several clinical implications. First, early POCD should not be regarded as transient or benign, because it was independently associated with increased 1-year mortality. Routine cognitive screening before and after surgery, particularly in older patients undergoing moderate to major surgery, may help identify those at high risk of poor long-term outcomes.

Second, risk stratification in older surgical patients should not rely on age or surgical risk alone but should also incorporate cognitive status and major comorbidities. These factors appear to reflect overall physiological vulnerability and reduced reserve, which are important determinants of long-term survival.

Third, high-risk patients may benefit from targeted perioperative interventions, including delirium and POCD prevention, optimization of comorbidities, nutritional support, early mobilization, and structured postoperative follow-up. A multidisciplinary approach involving surgeons, anesthesiologists, geriatricians, and rehabilitation teams may help reduce postoperative complications, functional decline, and long-term mortality. Finally, the association between naming-domain decline and 1-year mortality suggests that domain-specific cognitive changes may add prognostic information beyond global scores, although this requires validation in larger studies.

Conclusions

The incidence of 1-year mortality among older patients undergoing moderate to major surgery was 5.7%. Early POCD was independently associated with increased 1-year mortality. Advanced age, cancer, and advanced CKD were also independent predictors, reflecting the combined effects of frailty, comorbidity burden, and reduced physiological and cognitive reserve. A greater decline in the MoCA naming domain was associated with increased 1-year mortality, suggesting that domain-specific cognitive decline may have prognostic significance. These findings underscore the importance of perioperative cognitive assessment and comprehensive geriatric evaluation in older surgical patients. Identifying high-risk patients may enable targeted perioperative management and closer follow-up to improve long-term outcomes. Further multicenter studies are needed to confirm the association between domain-specific cognitive decline and long-term mortality, and to determine whether preventing POCD can improve survival in this population.

Declarations

Acknowledgments

The authors thank Monai Sauejui, Pavida Srichant, Suthisa Chamadol, and Pensri Chaoppanitwet for their assistance with data collection. We also extend our gratitude to Associate Professor Chulalak Komoltri for assistance with the statistical analysis and interpretation.

Funding

This research was supported by the Faculty of Medicine Siriraj Hospital, Mahidol University (grant number R016037003).

Author contributions statement

PM, AS, and PS were responsible for the conceptualization. PM and AS handled the methodology. AS oversaw validation. PM carried out the formal analysis. AS and VS managed resources. PM, US, BP, NS and CJ evaluated the data. PM and AS drafted the original manuscript. PM, AS, PS, WM and VS reviewed and edited the manuscript. AS, PS, and VS supervised the project, handled administration, and acquired funding. All authors contributed to the article and approved the submitted version.

Data availability

Data sets generated during the current study are available from the corresponding author on reasonable request.

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Tables

Table 1: Preoperative demographic and clinical characteristics of patients

Variable	Total patients *N* = 508	Alive *N* = 479; 94.3%	Dead *N* = 29; 5.7%	*P* value
Demographic data				
Age, years, mean (SD)	71.23 (6.34)			
Age ≥ 70 years, *n* (%)	315 (62%)	291 (60.8%)	24 (82.8%)	0.018
Male sex, *n* (%)	350 (56.5%)	268 (55.9%)	21 (72.4%)	0.082
Underweight (BMI < 18.5 kg/m^2), *n* (%)	26 (5.1%)	20 (4.2%)	6 (20.7%)	< 0.001
Education > 6 years, *n* (%)	281 (55.3%)	264 (55.1%)	17 (58.6%)	0.712
Preoperative data				
ASA ≥ 3, *n* (%)	358 (70.5%)	336 (70.1%)	22 (75.9%)	0.512
Comorbidities, *n* (%)				
Hypertension	413 (81.3%)	389 (81.2%)	24 (82.8%)	0.836
Dyslipidemia	356 (70.1%)	336 (70.1%)	20 (69.0%)	0.893
Diabetes mellitus	172 (33.9%)	161 (33.6%)	11 (37.9%)	0.633
Asthma or COPD	40 (7.9%)	35 (7.3%)	5 (17.2%)	0.054
Chronic kidney disease	76 (15%)	66 (13.8%)	10 (34.5%)	0.002
Cardiovascular disease	281 (55.3%)	262 (54.7%)	19 (65.5%)	0.255
Thyroid disease	21 (4.1%)	20 (4.2%)	1 (3.4%)	0.849
Cancer	155 (30.0%)	139 (29.0%)	16 (55.2%)	0.003
CVA	55 (10.8%)	48 (10.0%)	7 (24.1%)	0.018
Anemia	271 (53.3%)	250 (52.2%)	21 (72.4%)	0.034
Preoperative MoCA score, mean (SD)	19.17 (4.86)	19.26 (4.8)	17.69 (5.2)	0.092

Data are presented as *n* (%) unless otherwise indicated.
Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; MoCA, Montreal Cognitive Assessment; *N*, total number of patients; *n*, number of patients.

Table 2: Perioperative data of patients, *N* = 508

Variable	Total patients *N* = 508	Alive *N* = 479; 94.3%	Dead *N* = 29; 5.7%	*P* value
Intraoperative data, *n* (%)				
Site of surgery				0.558
Intrathoracic	271 (53.3%)	254 (53%)	17 (58.6%)	
Extrathoracic	237 (46.7%)	225 (47%)	12 (41.4%)	
Anesthetic technique				0.279
GA with or without RA	462 (90.9%)	434 (90.6%)	28 (96.6%)	
Regional anesthesia	46 (9.1%)	45 (9.4%)	1 (3.4%)	
Benzodiazepine use	170 (33.5%)	161 (33.6%)	9 (31%)	0.775
Opioid use	507 (99.8%)	478 (99.8%)	29 (100%)	0.805
Postoperative data (on the ward)				
Nosocomial infection	38 (7.5%)	32 (6.7%)	6 (20.7%)	0.005
Airway obstruction	6 (1.2%)	4 (0.8%)	2 (6.9%)	0.003
Pulmonary embolism	3 (0.6%)	3 (0.6%)	0 (0%)	0.669
Hypoxemia	42 (8.3%)	37 (7.7%)	5 (17.2%)	0.071
Reintubation	7 (1.4%)	7 (1.5%)	0 (0%)	0.512
Cardiac arrest	2 (0.4%)	1 (0.2%)	1 (3.4%)	0.007
Acute kidney injury	76 (15%)	70 (14.6%)	6 (20.7%)	0.373
Arrhythmia	126 (24.8%)	118 (24.6%)	8 (27.6%)	0.721
Coma	2 (0.4%)	2 (0.4%)	0 (0%)	0.727
Postoperative CVA	4 (0.8%)	4 (0.8%)	0 (0%)	0.621
Convulsion	4 (0.8%)	3 (0.6%)	1 (3.4%)	0.095
Postoperative delirium	92 (18.1%)	83 (17.3%)	9 (31%)	0.063
Myocardial ischemia	4 (0.8%)	3 (0.6%)	1 (3.4%)	0.095
Urinary retention	11 (2.2%)	10 (2.1%)	1 (3.4%)	0.625
Reoperation	14 (2.8%)	14 (2.9%)	0 (0%)	0.351
Ventilator use	246 (48.4%)	232 (48.4%)	14 (48.3%)	0.987
Hospital-based outcomes				

Length of ICU stay, days, median (IQR)	1 (1–2)	1 (0–2)	2 (0–4)	0.199
Length of hospital stay, days, median (IQR)	8 (6–12)	8 (6–11)	11.5 (9–16.75)	< 0.001
Hospital mortality, *n* (%)	2 (0.4%)	0 (0%)	2 (6.9%)	< 0.001
Postoperative MoCA, mean (SD)	19.51 (5.28)	19.68 (5.2)	16.69 (6.3)	0.003
POCD at 1 week	126 (24.8%)	114 (23.8%)	12 (41.4%)	0.033

Data are presented as *n* (%) and Median (IQR).
Abbreviations: CVA, cerebrovascular accident; GA, general anesthesia; ICU, intensive care unit; MoCA, Montreal Cognitive Assessment; *N*, total number of patients; *n*, number of patients; POCD, postoperative cognitive dysfunction; RA, regional anesthesia.

Table 3: Univariable and multivariable analysis of factors associated with 1-year mortality

Variable	**Univariable**		**Multivariable**	
	Crude HR (95% CI)	***P* value**	**Adjusted HR (95% CI)**	***P* value**
POCD	2.18 (1.04–4.57)	0.039	2.72 (1.27–5.84)	0.010
CKD stage 4–5	3.12 (1.45–6.70)	0.004	3.11 (1.33–7.27)	0.009
Cancer	2.88 (1.38–5.98)	0.005	4.27 (1.97–9.25)	< 0.001
Age ≥ 70 years	3.01 (1.15–7.90)	0.025	2.66 (1.01–7.04)	0.049
Anemia	2.37 (1.05–5.34)	0.038	1.72 (0.72–4.14)	0.223

Abbreviations: CKD, chronic kidney disease; HR, hazard ratio; POCD, postoperative cognitive dysfunction.

Table 4: Cognitive domains involved in postoperative cognitive dysfunction and their relationship with 1-year mortality

MoCA domain (maximum score)	Assessment	POCD, *N* = 126		*P* value
		Alive *n* = 114	Dead *n* = 12	
Visuospatial/executive (total = 5)	Pre	2.78 (1.41)	2.58 (1.38)	–
	Post	1.82 (1.38)	1.17 (1.40)	–
	Pre–post difference	0.96 (1.20)	1.42 (1.51)	0.414
Naming (total = 3)	Pre	2.62 (0.79)	2.92 (0.29)	–
	Post	2.58 (0.83)	2.25 (1.06)	–
	Pre–post difference	0.04 (0.43)	0.67 (0.89)	< 0.001
Attention (total = 6)	Pre	4.78 (1.17)	4.42 (1.68)	–
	Post	3.75 (1.45)	2.75 (1.71)	–
	Pre–post difference	1.04 (1.27)	1.67 (2.02)	0.249
Language (total = 3)	Pre	1.21 (1.06)	1.17 (1.19)	–
	Post	0.75 (0.88)	0.58 (0.90)	–
	Pre–post difference	0.46 (0.86)	0.58 (0.79)	0.676
Abstraction (total = 2)	Pre	0.61 (0.83)	0.58 (0.90)	–
	Post	0.39 (0.67)	0.50 (0.67)	–
	Pre–post difference	0.21 (0.66)	0.08 (0.52)	0.647
Delayed recall (total = 5)	Pre	2.24 (1.74)	1.33 (1.44)	–
	Post	2.00 (1.70)	1.33 (1.37)	–
	Pre–post difference	0.24 (1.37)	0.00 (1.35)	0.570
Orientation (total = 6)	Pre	5.46 (1.03)	4.58 (1.51)	–
	Post	4.14 (1.40)	3.50 (1.62)	–
	Pre–post difference	1.32 (1.29)	1.08 (1.17)	0.631

P values were calculated using the Mann–Whitney *U* test.

Data are presented as mean (SD).

An en dash (–) indicates that no statistical comparison was performed; *P* values were calculated for the pre–post difference only.

Abbreviations: MoCA, Montreal Cognitive Assessment; *N*, total number of patients; *n*, number of patients; POCD, postoperative cognitive dysfunction.

Figures

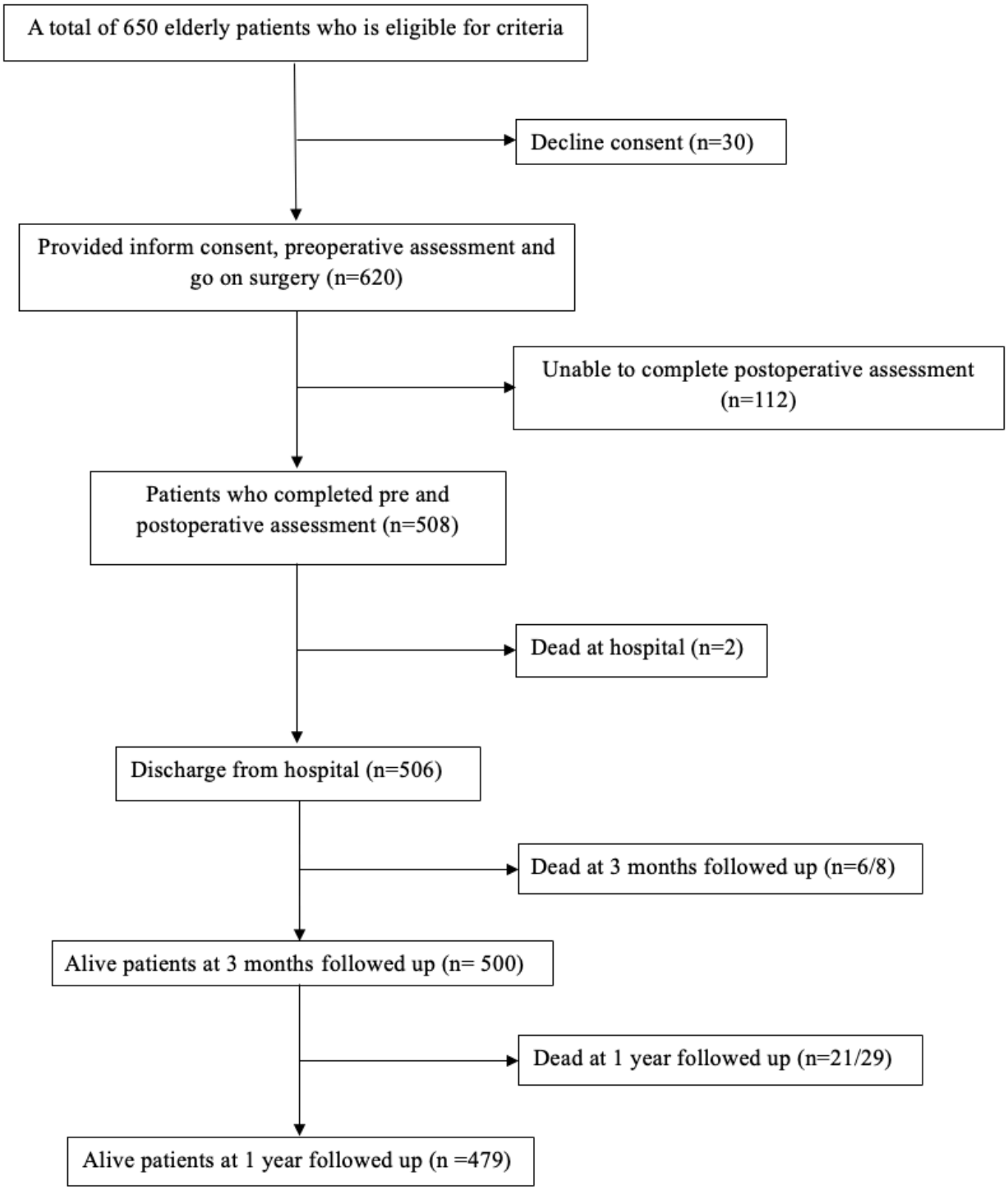

Figure 1

Flow of patients through the study, from enrollment to 1-year follow-up