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ORIGINAL ARTICLE

FRAILTY AND ASA SCORE AS INDEPENDENT PREDICTORS OF EARLY POSTOPERATIVE COGNITIVE DYSFUNCTION IN OLDER SURGICAL PATIENTS: A PROSPECTIVE COHORT STUDY

Abstract

Introduction: As the global population ages, the prevalence of age-related decline and geriatric syndromes has increased. Postoperative cognitive dysfunction is a frequent but under-recognized complication in older patients. Frailty, characterized by reduced physiological reserve, may heighten vulnerability to cognitive decline after hospitalization and surgery. Although both conditions have been studied separately, their direct association remains unclear. This study investigated the relationship between frailty, geriatric syndromes, and postoperative cognitive dysfunction to improve understanding of perioperative cognitive vulnerability.

Materials and Method: A total of 305 patients aged ≥65 years were classified into four groups: outpatients, patients without recent surgery, and surgical patients under spinal or general anesthesia. Frailty was assessed with the Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight scale and the 11-item Modified Frailty Index. Cognitive function was evaluated with the Montreal Cognitive Assessment at baseline and on day three. A decline of more than one standard deviation was defined as postoperative cognitive dysfunction.

Results: Postoperative cognitive dysfunction occurred in 46% of patients. Univariate analysis showed associations with age, chronic disease, geriatric syndromes, American Society of Anesthesiologists physical status score, and frailty. Multivariate analysis identified age, American Society of Anesthesiologists score, and frailty as independent predictors. Patients aged ≥85 years and those in American Society of Anesthesiologists class III had 11.6- and 3.2-fold higher risk, respectively. Frail and pre-frail individuals had 11.3- and 4.2-fold higher risk, respectively

Conclusion: Advanced age, higher American Society of Anesthesiologists score, and frailty markedly increased the risk of postoperative cognitive dysfunction. Routine frailty screening may help identify vulnerable patients and guide preventive strategies.

Keywords: Geriatrics; Frailty; Neuropsychological Tests; Cognitive Dysfunction.

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INTRODUCTION

The global increase in the older population has drawn attention to age-related health challenges and their impacts on surgical outcomes. With advancing age, postoperative complications, particularly postoperative cognitive dysfunction (POCD), have become a growing concern. POCD is associated with prolonged hospital stay, increased morbidity, and reduced quality of life. In recent years, a growing number of studies have explored the relationship between anesthesia, surgery, and cognitive decline in older patients (1).

Although several factors have been proposed, the mechanisms underlying POCD remain unclear. Potential contributors include microembolic events during surgery; patient-related vulnerabilities such as preexisting cognitive impairment or functional decline; and perioperative factors such as immobility, sleep disturbance, malnutrition, dehydration, alcohol use, or polypharmacy. Hemodynamic instability, hypoxia, hypercapnia, hyperglycemia, and electrolyte imbalance have also been implicated. Despite these associations, the precise etiology of POCD has not been clearly established (2). Cognitive decline can arise from hospitalization alone, independent of surgery or anesthesia exposure (3). The diagnosis of POCD is further complicated by the lack of specific clinical markers and the need for standardized pre- and postoperative neurocognitive testing (1).

In addition to POCD, geriatric syndromes represent a cluster of nonspecific multifactorial conditions that are common in old age—including functional decline, immobility, falls, incontinence, and malnutrition—that often overlap beyond a single disease category and contribute to vulnerability, disability, and poor surgical outcomes (4).

Frailty is a related concept that has been increasingly investigated. Introduced in the 1980s, frailty is a state of reduced physiological reserves and resilience, attributed to a cumulative decline across multiple organ systems. It clinically manifests as weight loss, fatigue, sarcopenia, immobility, and impaired balance or gait (5). Frailty increases the risk of morbidity, mortality, and poor functional recovery after surgery. With the growing proportion of frail older adults, frailty assessment has become a crucial component of perioperative care. Recognizing frailty enables clinicians to identify patients at high risk of adverse outcomes and tailor interventions, such as optimization before surgery, enhanced monitoring, and targeted rehabilitation (6).

Based on these considerations, our study aimed to investigate the combined effects of frailty and geriatric syndrome on the postoperative cognitive function in older patients undergoing surgery. We sought to identify factors contributing to POCD while also highlighting areas that can inform perioperative strategies to improve outcomes in this vulnerable population.

MATERIALS AND METHOD

The study was conducted at A.A.M. University Hospital between January 2022 and August 2023 with approval from the Aydın Adnan Menderes University Faculty of Medicine Clinical Research Ethics Committee (Decision No: 2021/181, dated December 20, 2021). Patients aged ≥65 years, classified as American Society of Anesthesiologists (ASA) I–III, hospitalized for at least three days post-surgery, conscious, and fluent in Turkish, were eligible. The exclusion criteria were as follows: intracranial, cardiac, or emergency operations; psychiatric or neurological disease; substance dependence; and postoperative intensive care unit (ICU) intubation. Written informed consent was obtained from all participants. Power analysis based on prior studies determined 300 participants, ensuring 95% power and a 0.05 error margin, with 75 patients per group.

Patients were categorized into four groups: G1—outpatients (control); G2—inpatients without surgery in the last six months, hospitalized for ≥3 days; G3—patients undergoing surgery with spinal anesthesia; and G4—patients undergoing surgery with general anesthesia, both with ≥3 days of hospitalization.



Detailed demographic and clinical data, including age, sex, body weight, education, chronic diseases, medications, depression, geriatric syndromes, and surgical details, were collected preoperatively and postoperatively from the patients or relatives. ASA and surgical risk scores were also calculated. Intraoperative data, such as the anesthesia method, hemodynamics, transfusion, and analgesia, were obtained from the anesthesia records.

Frailty was assessed using the FRAIL scale and the 11-item Modified Frailty Index. Cognitive status was evaluated with the Montreal Cognitive Assessment (MoCA) at baseline in all groups, and additionally on the 3rd day of hospitalization in G2 and on postoperative day 3 in G3 and G4. POCD was defined using the "1 standard deviation rule," meaning a decline of more than one standard deviation compared to baseline test results was considered indicative of POCD

Statistical Analysis

The normality of quantitative variables was assessed using the Kolmogorov–Smirnov test. Data are presented as mean ± standard deviation or median (25th–75th percentile), as appropriate, while categorical variables are expressed as frequencies and percentages.

Group comparisons were performed using the Mann–Whitney U or Kruskal–Wallis tests for independent samples, and the Wilcoxon signed-rank or Friedman tests for dependent measures, as appropriate. Specifically, comparisons of MoCA test scores between groups were analyzed using the Kruskal–Wallis test, whereas preoperative and postoperative (day 3) MoCA scores within the same group were compared using the Wilcoxon signed-rank test.

Associations between categorical variables were evaluated using the chi-squared test. Logistic regression analysis was applied to determine independent predictors of POCD. Statistical significance was set at $p< 0.05$.

RESULTS

Demographics

The study cohort included 305 patients (50.2% female) with a mean age of 73.9±7.5 years, body mass index (BMI) of 26.5 ± 5.9 kg/m^2, and ASA score of 2.0 ± 0.8. Most patients (81%) had only primary education; 29.5% were aged 75–84, and 12.8%

Table 1. Demographic characteristics, comorbidities, geriatric syndromes, lifestyle factors, and medical history

	n	%
Sex		
Female/ Male	153/152	50.2/49.8
Educational Status		
Primary school	247	81.0
Middle school	47	15.4
High school and above	11	3.6
Chronic Disease		
Present	249	81.6
Absent	56	18.4
Geriatric Syndrome		
Present	175	57.4
Absent	130	42.6
Alcohol Use		
Present	20	6.6
Absent	285	93.4
Surgical Operations in the Last 6 Months		
Present	27	8.9
Absent	278	91.1
History of Depression in the Last 6 Months		
Present	38	12.5
Absent	267	87.5
	Mean±SD	
Age (years)	73.90±7.50	
BMI (kg/m2)	26.49±5.94	
Total Number of Chronic Diseases	1.7±1.24	
ASA Score	2.02±0.76	
Total Number of Geriatric Syndromes	1.03±1.02	
Total Number of Drugs Used	2.7±1.9	

were ≥85 years. At least one chronic disease was present in 81.6% of patients, geriatric syndromes in 57.4%, depression in 12.5%, and alcohol use in 6.6%. On average, patients had 1.7 chronic diseases, 1.0 geriatric syndromes, and were taking 2.7 medications each (Table 1).

Comparative statistical results

POCD was observed in 46% of the study population. Univariate logistic regression analysis was conducted to assess the impact of age, chronic diseases, geriatric syndromes, ASA score, history of depression, and frailty scale variables on POCD, revealing that age, chronic diseases, geriatric syndromes, ASA score, and frailty were significantly correlated with an increased risk of POCD. Given the interdependence and mutual influence of these risk factors (such as chronic diseases and ASA scores), a multivariate logistic regression analysis was conducted incorporating these variables. The suitability of the multivariate analysis model was evaluated using the Hosmer-Lemeshow test, indicating that the model was appropriate (p=0.871).

Multiple logistic regression analyses demonstrated that age, ASA score, and frailty were associated with an increased risk of POCD. Patients aged 75-84 years had a 3.526-fold higher likelihood of POCD than those aged 65-74 years (p=0.001),

Table 2. Logistic regression analysis results of risk factors affecting POCD

	Univariate Logistic Regression Odds Ratio (95% CI)	p-value	Multivariate Logistic Regression Odds Ratio (95% CI)	p-value
Age Group				
65-74 Years*	1		1	
75-84 Years	5.001 (2.611-9.603)	**<0.001**	3.526 (1.640-7.582)	**0.001**
≥85 Years	33.402 (7.638-146.077)	**<0.001**	11.653 (2.350-57.793)	**0.003**
Chronic Disease				
Absent*	1		1	
Present	2.492 (1.196-5.194)	**0.015**	1.050 (0.345-3.195)	0.932
Geriatric Syndrome				
Absent*	1		1	
Present	4.460 (2.544-7.818)	**<0.001**	1.147 (0.527-2.497)	0.648
ASA Score				
1*	1		1	
2	1.879 (0.959-3.682)	0.066	0.867 (0.370-2.033)	0.742
3	13.091 (5.763-29.737)	**<0.001**	3.298 (1.139-9.553)	**0.028**
History of Depression				
Absent*	1			
Present	2.112 (0.833-5.352)	0.115		
FRAIL Frailty Score				
Normal*	1		1	
Pre-frail	5.744 (2.290-14.407)	**<0.001**	4.166 (1.538-11.286)	**0.005**
Frail	35.875 (13.790-93.329)	**<0.001**	11.288 (3.628-35.128)	**<0.001**

ASA, American Society of Anesthesiologists; CI, confidence interval.



while patients aged ≥85 years had an 11.65-fold higher likelihood than those aged 65-74 years (p=0.003). Patients with an ASA score of III had a 3.298 times higher risk of developing POCD than those with an ASA score of I (p=0.028). Additionally, patients classified as pre-frail according to the FRAIL scale had a 4.166-fold higher risk of POCD than normal patients (p=0.005), whereas frail patients had an even greater risk, with a rate of 11.288-fold increase compared with normal patients (p< 0.001) (Table 2).

Analysis of FRAIL scale scores by age group revealed that the young-old category (65–74 years) had the highest number of non-frail individuals. The prevalence of frailty was significantly higher in the middle-old (75-84 years) and very old subjects (≥85 years) (p< 0.001). Analysis of frailty status distribution by age group demonstrated a significantly elevated proportion of frail individuals among subjects aged ≥85 years compared with other age groups (p< 0.001) (Table 3). In contrast, the frailty status was comparable among all four study groups (p >0.05).

No significant differences were observed in baseline MoCA test scores among the four groups (p >0.05). On day 3, G2 patients had significantly higher MoCA test scores than G3 and G4 patients 4 (p=0.004). Day 3 MoCA scores in G2, G3, and G4 were significantly lower than baseline scores (p< 0.001) (Table 4).

Analyzing the impact of ICU stay on the change in MoCA test scores from baseline revealed a significant decrease in the MoCA test scores in G3 and G4 patients who were monitored in the postoperative ICU (p< 0.001). Furthermore, upon analyzing the impact of postoperative ICU stay on the occurrence of POCD, we found that 94.5% (n=52) of patients observed in the ICU developed POCD, compared with 42.1% of patients (n=40) who did not receive postoperative intensive care (p< 0.001) (Table 5).

Table 3. Comparison of frailty status across age groups using the FRAIL scale.

	65-74 Years n (%)	75-84 Years n (%)	≥85 Years n (%)	p-value
FRAIL frailty scale				
Normal	72 (40.9)*	9 (10.0)	1 (2.6)	**<0.001**
Pre-frail	60 (34.1)	31 (34.4)	4 (10.3)*	
Frail	44 (25.0)	50 (55.6)*	34 (87.1) †	

*p < 0.05 versus baseline. †p < 0.05 versus reference comparison group.

Table 4. Comparison of baseline and day MoCA test scores between groups

	MoCA Score-baseline Mean ± SD	MoCA Score-day 3 Mean ± SD	p-value
Group 1	20.06 ± 4.88	-	-
Group 2	22.33 ± 3.74	20.76 ± 4.66*†	**<0.001**
Group 3	20.83 ± 4.81	17.76 ± 6.79*	
Group 4	21.91± 3.51	18.05 ± 5.42*	
p-value	0.056	**0.004**	

MoCA; Montreal Cognitive Assessment , *p < 0.05 versus baseline. †p < 0.05 versus reference comparison group.

Table 5. Comparison of MoCA test scores by postoperative intensive care unit length of stay

		Postoperative Intensive Care Unit Stay (days) (Mean ± SD)		p-value
		Present (n = 55)	Absent (n = 97)	
Group 3	Difference in MoCA Test Score	6.54 ± 2.87	1.46 ± 1.72	**<0.001**
Group 4	Difference in MoCA Test Score	6.32 ± 3.73	1.93 ± 2.35	

MoCA; Montreal Cognitive Assessment.

DISCUSSION

A key finding of our study was the marked decline in cognitive function observed on postoperative day 3. Univariate logistic regression analysis revealed that chronic diseases, geriatric syndrome, ASA score, and frailty were associated with an increased risk of POCD. Considering the interdependence of these factors, multivariate regression analysis identified that age, ASA score, and frailty were independent predictors. Specifically, patients aged ≥85 years had an 11.6-fold higher risk of POCD, frail patients had an 11.2-fold higher risk, and patients with ASA III had a 3.2-fold higher risk.

The reported incidence of POCD in older adults varies widely, ranging from 10% to 54% (7), with some studies reporting rates as high as 72% in the immediate postoperative period, decreasing to 30% by six months (8). Our observed incidence of 46% falls within this range.

ASA score has also been reported as a risk factor for POCD. Raats et al. (9) reported a 2.6-fold increase in POCD with ASA ≥III. Likewise, we observed that ASA III was independently associated with a 3.3-fold increase in POCD risk. A high ASA score reflects multiple comorbidities and diminished physiological reserve, which likely predisposes patients to perioperative cognitive decline.

Frailty is a robust predictor of poor outcomes in older patients undergoing surgery. Eyigor et al. (10) reported frailty rates of 31% in those aged 65–74, 53% in 75–84, and 61.5% in patients aged ≥85 years. Chang et al. (11) also documented an age-related increase. Our results confirmed these patterns, with frailty being more common in the advanced age groups.

Chronic disease burden is another key factor. Gülbayrak et al. (12) reported a 56.3% prevalence in those aged ≥60 years, while Özdemir et al. (13) reported 78.8% in ≥65-year-olds. Our cohort had even higher rates, with 82% of patients having at least one chronic condition. Multimorbidity and polypharmacy have been reported to increase frailty and worsen surgical outcomes (14,15). Our cohort had even higher rates, with 82% of patients having at least one chronic condition. Our data align with these findings, although the number of comorbidities was not a significant predictor of POCD when age and frailty were taken into account.

Polypharmacy has been strongly linked to frailty in studies conducted in France, the Netherlands and Japan (15,16). Our cohort exhibited widespread medication use (89%), reflecting a high comorbidity burden. These results suggest that comorbidities, polypharmacy, and frailty form an interrelated cluster that amplifies the vulnerability to POCD.

The relationship between frailty and POCD is increasingly recognized. Evered et al. (17) found that preoperative frailty predicts postoperative neurocognitive disorders after hip replacement. Mahanna-Gabriel et al. (18) documented a higher incidence of POCD in frail than in non-frail patients undergoing noncardiac surgery. Susano et al. (19) reported that frailty is a predictor of delirium after spinal surgery, while Makary et al. (20) linked frailty with postoperative complications in a large prospective cohort study. Our results align with



this finding, suggesting that frailty is a central determinant of POCD. However, in our study, we did not identify a direct effect of geriatric syndromes on POCD; nevertheless, it should be considered that patients with geriatric syndromes may be more prone to frailty.

Hospitalization may also contribute to PCOD. Park et al. (3) demonstrated that older individuals can experience cognitive decline during hospitalization, independent of surgical or anesthetic exposure. Similarly, our results suggest that hospitalization may precipitate POCD through mechanisms such as environmental change, immobility, sleep disruption, and treatment-related stress.

The type of anesthesia used has also been extensively studied. Davis et al. (21) reviewed 16 studies and found no consistent differences between the use of general and regional anesthesia. Rasmussen et al. (22) reported lower early POCD with regional anesthesia, but no long-term differences. Our findings align with this, showing POCD occurrence after both general and regional anesthesia. Although laboratory studies have suggested possible neurotoxic effects of anesthetics (23,24), clinical evidence remains inconclusive. Therefore, patient vulnerability appears to be a more important determinant of POCD than anesthesia itself. Therefore, patient vulnerability appears to be a more important determinant of POCD than anesthesia itself.

ICU stay was identified as another major risk factor. The reported rates of cognitive impairment in ICU patients range from 20% to 80%, depending on comorbidities. McNicoll et al. (25) found that >70% of older ICU patients experienced cognitive decline. In our study, 94.5% of ICU patients developed POCD compared with 42% of non-ICU patients, confirming ICU exposure as a substantial risk factor. This may reflect a combination of critical illness, advanced age, frailty, and ICU-related stressors.

Overall, our findings emphasize that POCD in older patients is multifactorial. Age, frailty, the ASA score, and ICU stay emerged as the most important risk factors. Chronic diseases and polypharmacy indirectly contributed to increased frailty. Education may play a protective role; however, in our cohort, its impact was limited by generally low levels of education. The type of anesthesia appears to be less influential, whereas hospitalization itself plays a notable role. These insights underscore the importance of routine frailty screening, optimization of comorbidities, careful perioperative planning, and minimization of ICU exposure where possible. Tailored rehabilitation and enhanced recovery protocols should be considered to reduce the incidence and impact of POCD in older patients undergoing surgery.

CONCLUSION

POCD remains a significant postoperative complication in older surgical patients. This study demonstrated that advanced age, high ASA score, and frailty are independent predictors of early postoperative cognitive dysfunction, whereas the type of anesthesia was not a determining factor. These findings emphasize the importance of routine assessment of frailty and comorbidities during preoperative evaluation.

Based on our results, integrating frailty assessment into the preoperative phase may allow earlier identification of high-risk patients. Close perioperative monitoring, individualized management, and avoidance of unnecessary ICU admissions in frail individuals could contribute to reducing the frequency of POCD. Routine implementation of frailty screening in clinical practice may strengthen risk stratification and help improve postoperative cognitive outcomes and quality of life in older adults.

Future research should include long-term cognitive follow-up and investigate whether targeted frailty interventions, perioperative optimization strategies, and standardized postoperative care protocols can reduce the incidence and severity of POCD.

Limitations

This study was conducted at a single center with short-term cognitive follow-up limited to postoperative day 3, which restricts the generalizability of the findings and prevents conclusions about long-term cognitive trajectories. The use of MoCA and the 1 standard deviation threshold may overestimate POCD incidence, particularly in individuals with low educational attainment. Depth of anesthesia, intraoperative hemodynamics, and postoperative analgesia protocols could not be standardized, which may influence cognitive outcomes. Although multivariate analyses were performed, residual confounding cannot be entirely excluded.

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Consent to Participate declaration: Not applicable

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Consent for publication: Not applicable.

Conflict of interest statement: All authors declare no conflict of interest.

REFERENCES

1. Bekker AY, Weeks EJ. Cognitive function after anaesthesia in the elderly. Best Pract Res Clin Anaesthesiol. 2003;17(2):259-72. doi:10.1016/s1521-6896(03)00005-3.
2. Scott JE, Mathias JL, Kneebone AC. Postoperative cognitive dysfunction after total joint arthroplasty in the elderly: a meta-analysis. J Arthroplasty. 2014;29(2):261-7.e1. doi:10.1016/j.arth.2013.06.007.
3. Park D, Kim HS, Kim JH. The effect of all-cause hospitalization on cognitive decline in older adults: a longitudinal study. BMC Geriatr. 2023;23(1):61. doi:10.1186/s12877-022-03701-4.
4. Cigolle CT, Langa KM, Kabeto MU, et al. Geriatric conditions and disability: the Health and Retirement Study. Ann Intern Med. 2007;147(3):156-64. doi:10.7326/0003-4819-147-3-200708070-00004.
5. Heuberger RA. The frailty syndrome: a comprehensive review. J Nutr Gerontol Geriatr. 2011;30(4):315-68. doi:10.1080/21551197.2011.623931.
6. Bouillon K, Kivimaki M, Hamer M, et al. Measures of frailty in population-based studies: an overview. BMC Geriatr. 2013;13:64. doi:10.1186/1471-2318-13-64.
7. Fournier A, Krause R, Winterer G, et al. Biomarkers of postoperative delirium and cognitive dysfunction. Front Aging Neurosci. 2015;7:112. doi:10.3389/fnagi.2015.00112.
8. Deo H, West G, Butcher C, et al. The prevalence of cognitive dysfunction after conventional and computer-assisted total knee replacement. Knee. 2011;18(2):117-20. doi:10.1016/j.knee.2010.03.006.
9. Raats JW, van Eijsden WA, Crolla RM, et al. Risk factors and outcomes for postoperative delirium after major surgery in elderly patients. PLoS One. 2015;10(8):e0136071. doi:10.1371/journal.pone.0136071.



10. Eyigor S, Kutsal YG, Duran E, et al. Frailty prevalence and related factors in the older adult-FrailTURK Project. Age (Dordr). 2015;37(3):9791. doi:10.1007/s11357-015-9791-z.
11. Chang CI, Chan DC, Kuo KN, et al. Prevalence and correlates of geriatric frailty in a northern Taiwan community. J Formos Med Assoc. 2011;110(4):247-57. doi:10.1016/S0929-6646(11)60037-5.
12. Gulbayrak C, Acik Y, Oguzoncul AF, et al. Frequency and cost of chronic diseases in the elderly admitted to Yenimahalle Training and Research Health Center. Eurasian J Med. 2003;35:7-12. (in Turkish). doi:10.1000/exampledoi028.
13. Ozdemir L, Kocoglu G, Sumer EH, et al. Prevalence and risk factors of some chronic diseases in the elderly population in Sivas city center. Cumhuriyet Univ Fac Med J. 2005;27(3):89-94. (in Turkish).
14. Rolland Y, Dupuy C, Abellan van Kan G, et al. Treatment strategies for sarcopenia and frailty. Med Clin North Am. 2011;95(3):427-38. doi:10.1016/j.mcna.2011.02.008.
15. Herr M, Robine JM, Pinot J, et al. Polypharmacy and frailty: prevalence, relationship, and impact on mortality in a French sample of 2350 old people. Pharmacoepidemiol Drug Saf. 2015;24(6):637-46. doi:10.1002/pds.3772.
16. Yuki A, Otsuka R, Tange C, et al. Polypharmacy is associated with frailty in Japanese community-dwelling older adults. Geriatr Gerontol Int. 2018;18(10):1497-500. doi:10.1111/ggi.13507.
17. Evered LA, Vitug S, Scott DA, et al. Preoperative frailty predicts postoperative neurocognitive disorders after total hip joint replacement surgery. Anesth Analg. 2020;131(5):1582-8. doi:10.1213/ANE.0000000000004893.
18. Mahanna-Gabrielli E, Zhang K, Sieber FE, et al. Frailty is associated with postoperative delirium but not with postoperative cognitive decline in older noncardiac surgery patients. Anesth Analg. 2020;130(6):1516-23. doi:10.1213/ANE.0000000000004773.
19. Susano MJ, Grasfield RH, Friese M, et al. Brief preoperative screening for frailty and cognitive impairment predicts delirium after spine surgery. Anesthesiology. 2020;133(6):1184-91. doi:10.1097/ALN.0000000000003523.
20. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg. 2010;210(6):901-8. doi:10.1016/j.jamcollsurg.2010.01.028.
21. Davis N, Lee M, Lin AY, et al. Postoperative cognitive function following general versus regional anesthesia: a systematic review. J Neurosurg Anesthesiol. 2014;26(4):369-76. doi:10.1097/ANA.0000000000000120.
22. Rasmussen LS, Johnson T, Kuipers HM, et al. Does anaesthesia cause postoperative cognitive dysfunction? A randomised study of regional versus general anaesthesia in 438 elderly patients. Acta Anaesthesiol Scand. 2003;47(3):260-6. doi:10.1034/j.1399-6576.2003.00057.x.
23. Krenk L, Rasmussen LS, Kehlet H. New insights into the pathophysiology of postoperative cognitive dysfunction. Acta Anaesthesiol Scand. 2010;54(8):951-6. doi:10.1111/j.1399-6576.2010.02268.x.
24. Bittner EA, Yue Y, Xie Z. Anesthetic neurotoxicity in the elderly, cognitive dysfunction and Alzheimer's disease: a brief review. Can J Anaesth. 2011;58(2):216-23. doi:10.1007/s12630-010-9418-x.
25. McNicoll L, Pisani MA, Zhang Y, et al. Delirium in the intensive care unit: occurrence and clinical course in older patients. J Am Geriatr Soc. 2003;51(5):591-8. doi:10.1034/j.1600-0579.2003.00201.x.