Perioperative Brain Health

Dr Choy-May Leung[†]

Resident, Department of Anaesthesiology, Pain and Perioperative Medicine, Queen Mary Hospital/University of Hong Kong, Hong Kong

Edited by: Dr Clara Poon, Consultant Anaesthetist, Queen Mary Hospital/University of Hong Kong, Hong Kong, Dr William Francis Powell, Department of Anaesthesiology, Mass Eye and Ear (Boston, USA)/Clinical Instructor (Harvard Medical School, USA)

[†]Correspondence author email: leungchoymay@gmail.com

Published 5 May 2026

DOI: 10.28923/atotw.571

KEY POINTS

- Perioperative cognitive disorder is an overarching term that includes postoperative delirium, delayed neurocognitive recovery, and postoperative neurocognitive disorder.
- The preoperative visit is essential in identifying risk factors for initiation of risk-reduction strategies. The most consistent risk factors are old age and preoperative cognitive impairment.
- High-risk patients should have their baseline cognitive function established with a validated tool such as the Mini-Cog. They should also be informed of the risks of perioperative neurocognitive disorders as part of the consenting process.
- Intraoperative goals are to maintain cerebral perfusion and to minimise neurotoxic insults. This is achieved by avoiding significant physiological disturbances and excessive depth of anaesthesia.
- Postoperative goals are to optimise analgesia and facilitate reorientation. Postoperative delirium should be managed by excluding reversible causes and using nonpharmacological measures.

INTRODUCTION

Perioperative brain health refers to cognitive recovery after surgery and anaesthesia, which depends on both one's cognitive reserve and the extent of surgical or anaesthetic insults to the brain.[1] It is of particular concern to both patients and caregivers because it fundamentally changes one's identity and drastically impacts one's quality of life.[2]

The Brain Health Initiative was created by the American Society of Anaesthesiologists with the goal of optimising cognitive recovery and perioperative experience, especially for older adults undergoing surgery.[3] Older adults 65 years of age or above are disproportionately represented amongst patients undergoing surgery and anesthesia.[4] Physiological changes that occur with ageing diminish the body's reserve, thereby rendering it more vulnerable to perioperative insults.

Perioperative care bundles that focus on brain health are emerging. Principles follow those of Perioperative Medicine and divide perioperative care into the preoperative, intraoperative, and postoperative phases. The perioperative care team consists of not only the anaesthesiologist, surgeon, and neurogeriatrician but also the patient's primary care physician and other allied health members.

BACKGROUND

Definition and Epidemiology

Perioperative neurocognitive disorder is an overarching term that describes the cognitive changes identified in the perioperative period.[3] It is defined with reference to the *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition (DSM-5),[5] and is

An online test is available for self-directed continuous medical education (CME). It is estimated to take 1 hour to complete. Please record time spent and report this to your accrediting body if you wish to claim CME points. A certificate will be awarded upon passing the test. Please refer to the accreditation policy here.

TAKE ONLINE TEST

further classified into postoperative delirium, delayed neurocognitive recovery, and postoperative neurocognitive disorder, according to the duration of onset after surgery and anaesthesia (Figure 1).[6]

Postoperative delirium refers to changes in attention, cognition, and awareness within 7 days that have an acute onset with fluctuating course. Behavioural disturbances may coexist, which range from hyperactivity that manifests as agitation to hypoactivity that manifests as somnolence.

Neurocognitive disorder refers to significant decline from previous level of activities in at least 1 of the 6 cognitive domains: executive function, complex attention, social cognition, learning and memory, language, and perceptual motor function. It is classified as *delayed neurocognitive recovery* when it occurs within 30 days and *postoperative neurocognitive disorder* when it occurs within 12 months.

Postoperative delirium is estimated to occur in up to 65% of older patients,[7] while delayed neurocognitive disorder and postoperative neurocognitive disorder range from 17% to 43% depending on specific surgical specialty.[8]

Pathophysiology and Risk Factors

Systemic inflammatory response to surgery and anaesthesia is believed to be the key pathophysiological mechanism in perioperative neurocognitive disorders.[9-11] Patient-related risk factors are essentially indicative of a vulnerable brain, which may be a result of compromised cognitive reserve, neurotoxic insults, and impaired cerebral perfusion (Table 1). The most consistent risk factors are old age and preoperative cognitive impairment.

On the other hand, procedure-related risk factors (Table 2) are reflection of the strength of inflammatory response. They include magnitude or complexity of the procedure, duration, and specific surgical specialty.[12-14] Major cardiac, thoracic, and vascular procedures are associated with increased risk. Preexisting neuroinflammation or neurodegeneration either unmarks neurocognitive dysfunction or primes the brain to react more strongly to a systemic inflammatory and stress response.

Anaesthesia-related risk factors and medications (Table 2) associated with perioperative neurocognitive disorders are discussed in greater details in the subsequent section Perioperative Care. In recent years, several intraoperative electroencephalographic characteristics during general anaesthesia have been suggested to be markers of vulnerable brains—examples include diminished power of frontal alpha waves and the propensity of the brain to enter into burst suppression which may reflect reduced cerebral connectivity and decreased mitochondrial function or reserve, respectively.[15]

It is worth noting that this is a field of active research, with plenty of new theories and controversies. For instance, it has been postulated that the gut microbiome, being an essential part of the gut-brain axis, may also play a role in neuroinflammation and hence the development of neurocognitive disorders.[16]

Prognosis and Management

Postoperative delirium is associated with worse outcomes, such as prolonged hospitalisation, decline in functional status, and subsequent cognitive impairment.[17]

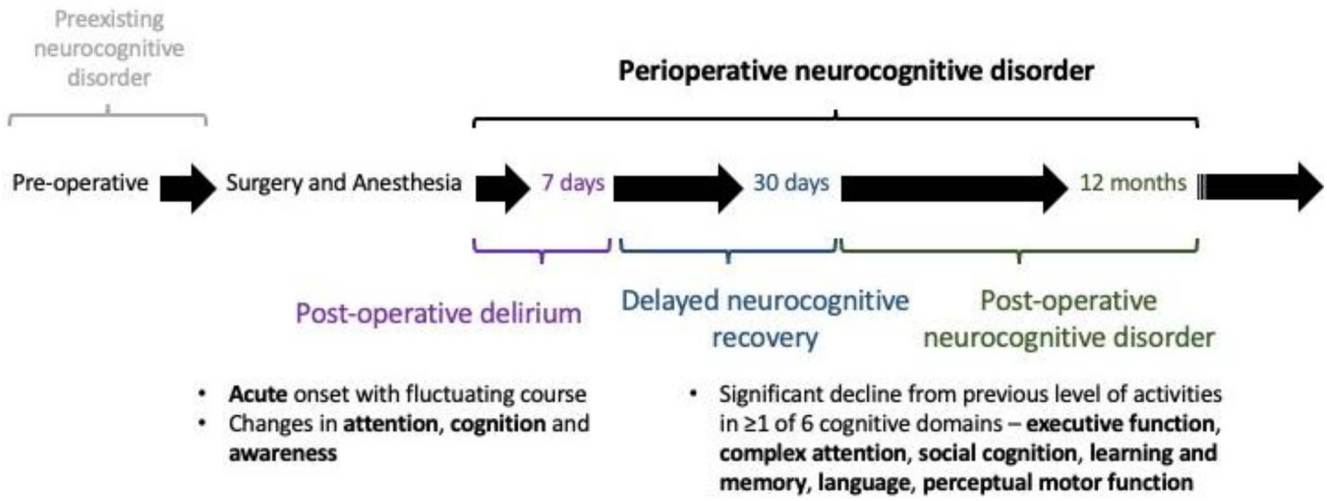

Figure 1. Definitions of perioperative neurocognitive disorder.[5]

Compromised Cognitive Reserve	Neurotoxic Insults	Impaired Cerebral Perfusion
• Old age >65 years • Cognitive impairment • Low educational level • Depression • Sleep disruption	• Diabetes mellitus • Chronic alcoholism • Psychotropic drug use • Polypharmacy	• Prior transient ischemic attack, stroke • Severe vascular disease

Table 1. Patient-Related Risk Factors for Perioperative Neurocognitive Disorders[11,26]

Reversible triggers, including pain, respiratory failure, electrolyte disturbances, hypothermia, or hypoglycaemia, should be identified and treated accordingly. A complete neurological assessment is warranted in patients not responding to initial management. Early Neurology or Neurosurgery input should be considered in the presence of lateralising signs or features of raised intracranial pressure suggestive of neurological complications. After ruling out reversible causes, nonpharmacological measures should be the first line of management, with antipsychotics being limited to only refractory delirium that poses risk of harm to patient or staff.[1]

A small proportion of patients with delayed neurocognitive recovery and postoperative neurocognitive disorder demonstrate persistent decline in subsequent cognitive testing.[18] As with nonoperative cases of neurocognitive disorders, no effective treatment is currently available. General management is similar to that of nonoperative causes, and patients should be referred to the Geriatric/Neurology team for long-term follow-up after discharge.[5]

PERIOPERATIVE CARE

Preoperative

The goals of the preoperative visit are to identify risk factors, stratify risk, initiate risk-reduction strategies, and disclose risks to patients or their family members. Risk assessment is performed to identify high-risk patients, who may subsequently require characterisation of preexisting cognitive level and modification of anaesthetic technique to minimise risks. Currently, no validated risk stratification tool for perioperative neurocognitive disorders[19] analogous to the Revised Cardiac Risk Index for major adverse cardiac events exists.

While a full set of cognitive tests is impossible for all patients in the clinical setting, a validated screening tool may instead be used to select patients for detailed assessments by neurogeriatricians. The Fifth International Perioperative Neurotoxicity Working Group recommended that baseline cognition should be objectively evaluated with a brief screening tool during preoperative evaluation in all patients over the age of 65 and any patient with risk factors for preexisting cognitive impairment.[13] The Mini-Cog test is amongst the most cited screening tool that is quick to perform, with a reasonable test sensitivity.[20] It consists of a 3-item registration, followed by a clock-drawing test, and finally a 3-item recall. Other commonly cited cognitive screening tools are the Montreal Cognitive Assessment[21] and the Minimal Mental State Examination.[22]

One of the most important risk reduction strategies is the optimisation of medical comorbidities, particularly control of vascular risk factors such as hypertension and diabetes mellitus. In addition, while polypharmacy is often unavoidable in the older adults, they should be screened for any potential interactions. Prescription of medicines for the geriatric population should also be in accordance with the American Geriatrics Society Beers Criteria for potentially inappropriate medication use in older adults.[23] Since optimisation of medical conditions often takes time, it can be ineffective and impractical if commencing only in the immediate preoperative period. Therefore, perioperative brain health involves not only the anaesthesiologists, surgeons, and neurogeriatricians but also the primary care physicians, who can aid in optimising patients before they present for surgery and anaesthesia.

In addition, all patients over age of 65 and their family members should be informed of the risks of perioperative neurocognitive disorder preoperatively.[24,25] This permits a reasonable level of expectation for the postoperative course of cognitive recovery, with pre-emptive actions to refrain from making major personal decisions in the immediate postoperative period. This also facilitates patients and their family members to actively participate in risk-reduction strategies, which include smoking cessation,

Procedure	Anaesthesia	Medication
• Procedural duration • Procedural complexity • Surgical approach • Cardiopulmonary bypass	• Intraoperative hypotension • Excessive depth of anesthesia • Hypoxemia • Hypothermia • Hypo/hyperglycaemia	• Benzodiazepines • Gabapentinoids • Opioids • Anticholinergic agents

Table 2. Procedure, Anaesthesia and Medication-Related Risk Factors for Perioperative Neurocognitive Disorders[11,26]

maintaining physical activity, bringing hearing aids and glasses for postoperative use, and having family or friends for visit after the procedure.[4]

Intraoperative

The overall intraoperative goals are to maintain cerebral perfusion and minimise neurotoxic insults. Specific issues include physiological parameters, anaesthetic agents, anaesthetic techniques, and monitoring. Hypotension should be avoided, as it decreases cerebral blood flow, although specific blood pressure targets are individualised.[26] In cases where significant hemodynamic changes are anticipated, arterial blood pressure and ventilation should be meticulously monitored and controlled. Normothermia and normoglycemia help to minimise stress.

Intravenous agents that have been implicated in the development of perioperative neurocognitive disorder include benzodiazepines, gabapentinoids, opioids, and anticholinergic agents. They should be used with caution and only when indicated in high-risk patients. While evidence is not well established for the use of dexmedetomidine in reducing risk of perioperative neurocognitive disorders, it may be used in high-risk patients with the aim of decreasing emergence delirium.[10]

Evidence is inconclusive in terms of the specific anaesthetic technique, anaesthetic depth, and depth of anaesthesia monitoring for reducing risks of perioperative neurocognitive disorders. Recommendations in these areas are therefore made based on best-practice guidelines.[17,27]

Compared with general anaesthesia, regional anaesthesia—whether with deep, light, or no sedation—has not been consistently shown to decrease the incidence of perioperative neurocognitive disorders.[13,28,29] That being said, appropriately administered regional techniques, in general, improve pain control and reduce opioid requirements. In addition, although total intravenous anaesthesia is less likely to produce emergence delirium especially in the paediatric group,[30] evidence again is inconclusive with regards to its use compared with volatile anaesthesia in decreasing risks of perioperative neurocognitive disorders in adults.[31-33] Thus, the decision of providing general or regional anaesthesia, total intravenous or volatile anaesthesia should not be made solely based on concerns for perioperative brain health.

On the other hand, excessive depth of anaesthesia is associated with an increased risk of perioperative neurocognitive disorder.[34-36] Electroencephalography (EEG) signatures indicative of reduced neuronal activity include power shift towards lower frequencies, power reduction across all frequencies, and ultimately burst suppression.[15] Evidence of benefits of depth of anaesthesia monitoring in mitigating its risks, however, has not been consistently demonstrated.[37-40] Nonetheless, it remains prudent to avoid excessive depth that could cause hypotension, compromising cerebral perfusion. The Fifth International Perioperative Neurotoxicity Working Group recommended that anaesthesiologists should monitor age-adjusted end-tidal minimal alveolar gas fraction and perform EEG-based anaesthetic management in older adults.[13] They provide additional information regarding the depth of anaesthesia in addition to clinical assessment findings such as heart rate and blood pressure.

Postoperative

The key postoperative goals are to optimise analgesia and facilitate reorientation.[4,24] Paracetamol and nonsteroidal anti-inflammatory drugs should be considered as part of the analgesic regimen. Although ketamine produces psychomimetic effects that may manifest as emergence delirium, it has analgesic and opioid-sparing properties that may be advantageous for patients with poor postoperative pain control. Patients' medications should be carefully reviewed at discharge, especially looking out for potential interactions and opioid dosing.

Multicomponent nonpharmacological interventions targeting patients at risk of postoperative delirium have been advocated. To facilitate reorientation, early mobilisation should be encouraged by removing unnecessary lines, drains, and restraints. Sensory input should be maintained by returning hearing aids and glasses to patients as soon as practicable, and any disruption to the sleep-wake cycle should be minimised. Family members or friends are encouraged to visit, whereas familiar objects such as photographs or music may also be helpful.[4,24] Input from the geriatrician, rehabilitation specialists, and social worker helps to identify medicopsychosocial issues and individualise cognitive training, risk prevention, and management bundles.

Delirium screening should be performed in the Postanaesthesia Care Unit to allow early intervention that include optimising analgesia and managing reversible causes.[24] They should also be followed up in the postoperative period for improvement or resolution of symptoms. The Confusion Assessment Method (CAM) is a validated screening tool for diagnosing delirium. It has been developed into a brief version termed the 3-Minute Diagnostic CAM (3D-CAM).[41] The 3D-CAM is a questionnaire that identifies features of delirium according to the DSM-5 criteria. It is considered positive when the patient demonstrates features of both acute onset with fluctuating course and inattention, plus either impaired cognitive function or altered level of consciousness. An alternative screening tool for delirium is the 4A's Test (4AT), which scores based on acuity, attention, abbreviated mental test, and arousal. A summary of strategies targeting perioperative brain health is illustrated in Figure 2.

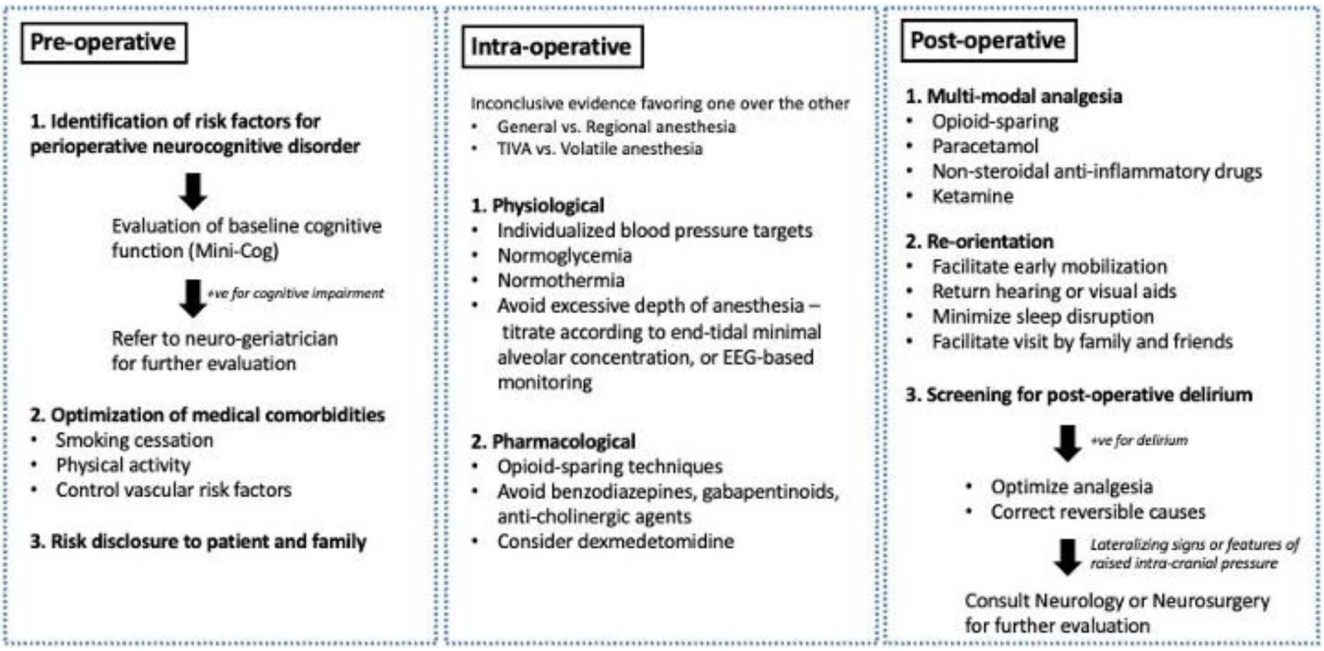

Figure 2. Summary of perioperative strategies targeting brain health.[23]

SUMMARY

Perioperative brain health requires joint effort from patients, their families, anaesthesiologist, surgeon, neurogeriatrician, primary care physician, and allied health members. Perioperative neurocognitive disorders are prevalent, with significant consequences on patient outcomes. Although some precipitating risk factors are nonmodifiable such as the age of the patient and the extent of surgery, many other factors are within the control of anaesthesiologists. Emerging perioperative care bundles help identify high-risk patients who would benefit from multidisciplinary risk-reduction strategies and facilitate timely management of perioperative neurocognitive disorders. Bearing in mind that perioperative neurocognitive disorders have a multifactorial genesis, with each patient having a unique risk profile, interventions should be individualised, as it is unlikely that any single intervention is sufficient for all.

REFERENCES

1. Wooding DJ, Field TS, Schwarz SKW, et al. Current recommendations for perioperative brain health: a scoping review. *J Neurosurg Anesthesiol*. 2023;35(1):10-18. doi:10.1097/ANA.0000000000000861
2. Steinmetz J, Christensen KB, Lund T, Lohse N, Rasmussen LS. Long-term consequences of postoperative cognitive dysfunction. *Anesthesiology*. 2009;110(3):548-555. doi:10.1097/ALN.0b013e318195b569
3. Evered L, Silbert B, Knopman DS, et al. Recommendations for the nomenclature of cognitive change associated with anaesthesia and surgery—2018. *Br J Anaesth*. 2018;121(5):1005-1012. doi:10.1016/j.bja.2017.11.087
4. Vacas S, Canales C, Deiner SG, Cole DJ. Perioperative brain health in the older adult: a patient safety imperative. *Anesth Analg*. 2022;135(2):316-328. doi:10.1213/ane.0000000000006090
5. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (5th ed.). 2013. https://doi.org/10.1176/appi.books.9780890425596.
6. Brodier EA, Cibelli M. Postoperative cognitive dysfunction in clinical practice. *BJA Educ*. 2021;21(2):75-82. doi:10.1016/j.bjae.2020.10.004
7. Rudolph JL, Marcantonio ER. Review articles: postoperative delirium: acute change with long-term implications. *Anesth Analg*. 2011;112(5):1202-1211. doi:10.1213/ANE.0b013e3182147f6d
8. Evered L, Scott DA, Silbert B, Maruff P. Postoperative cognitive dysfunction is independent of type of surgery and anesthetic. *Anesth Analg*. 2011;112(5):1179-1185. doi:10.1213/ANE.0b013e318215217e
9. Liu X, Yu Y, Zhu S. Inflammatory markers in postoperative delirium (POD) and cognitive dysfunction (POCD): a meta-analysis of observational studies. *PLoS One*. 2018;13(4):e0195659. doi:10.1371/journal.pone.0195659
10. Aldecoa C, Bettelli G, Bilotta F, et al. Update of the European Society of Anaesthesiology and Intensive Care Medicine evidence-based and consensus-based guideline on postoperative delirium in adult patients. *Eur J Anaesthesiol*. 2024;41(2):81-108. doi:10.1097/EJA.0000000000001876

11. Maldonado JR. Acute brain failure: pathophysiology, diagnosis, management, and sequelae of delirium. *Crit Care Clin*. 2017;33(3):461-519. doi:10.1016/j.ccc.2017.03.013
12. Hughes CG, Boncyk CS, Culley DJ, et al. American Society for Enhanced Recovery and Perioperative Quality Initiative joint consensus statement on postoperative delirium prevention. *Anesth Analg*. 2020;130(6):1572-1590. doi:10.1213/ane.0000000000004641
13. Berger M, Schenning KJ, Brown CH 4th, et al. Best practices for postoperative brain health: recommendations from the Fifth International Perioperative Neurotoxicity Working Group. *Anesth Analg*. 2018;127(6):1406-1413. doi:10.1213/ane.0000000000003841
14. Berian JR, Zhou L, Russell MM, et al. Postoperative delirium as a target for surgical quality improvement. *Ann Surg*. 2018;268(1):93-99. doi:10.1097/sla.0000000000002436
15. Guay CS, Agrawal U, Tseng B, Gallo S, Schreier DR, Brown EN. Clinical electroencephalography for anesthesiologists and intensivists: part 2—physiologic signatures and active management. *Anesthesiology*. 2025;143(6):1595-1618. doi:10.1097/aln.0000000000005739
16. Yang Y, Xu Z, Guo J, Xiong Z, Hu B. Exploring the gut microbiome–postoperative cognitive dysfunction connection: mechanisms, clinical implications, and future directions. *Brain Behav Immun Health*. 2024;38:100763. doi:10.1016/j.bbih.2024.100763
17. Witlox J, Eurelings LS, de Jonghe JF, Kalisvaart KJ, Eikelenboom P, van Gool WA. Delirium in elderly patients and the risk of postdischarge mortality, institutionalization, and dementia: a meta-analysis. *JAMA*. 2010;304(4):443-451. doi:10.1001/jama.2010.1013
18. Abildstrom H, Rasmussen LS, Rentowl P, et al. Cognitive dysfunction 1-2 years after non-cardiac surgery in the elderly. ISPOCD group. International study of post-operative cognitive dysfunction. *Acta Anaesthesiol Scand*. 2000;44(10):1246-1251. doi:10.1034/j.1399-6576.2000.441010.x
19. Kaustov L, Fleet A, Brenna CTA, Orser BA, Choi S. Perioperative neurocognitive screening tools for at-risk surgical patients. *Neurol Clin Pract*. 2022;12(1):76-84. doi:10.1212/cpj.0000000000001132
20. Borson S, Scanlan J, Brush M, Vitaliano P, Dokmak A. The mini-cog: a cognitive 'vital signs' measure for dementia screening in multi-lingual elderly. *Int J Geriatr Psychiatry*. 2000;15(11):1021-1027. doi:10.1002/1099-1166(200011)15:11<1021::aid-gps234>3.0.co;2-6
21. Nasreddine ZS, Phillips NA, Bedirian V, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *J Am Geriatr Soc*. 2005;53(4):695-699. doi:10.1111/j.1532-5415.2005.53221.x
22. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12(3):189-198. doi:10.1016/0022-3956(75)90026-6
23. 2023 American Geriatrics Society Beers Criteria® Update Expert Panel. American Geriatrics Society 2023 updated AGS Beers Criteria® for potentially inappropriate medication use in older adults. *J Am Geriatr Soc*. 2023;71(7):2052-2081. doi:10.1111/jgs.18372
24. Peden CJ, Miller TR, Deiner SG, Eckenhoff RG, Fleisher LA. Improving perioperative brain health: an expert consensus review of key actions for the perioperative care team. *Br J Anaesth*. 2021;126(2):423-432. doi:10.1016/j.bja.2020.10.037
25. Hogan KJ, Bratzke LC, Hogan KL. Informed consent and cognitive dysfunction after noncardiac surgery in the elderly. *Anesth Analg*. 2018;126(2):629-631. doi:10.1213/ane.0000000000002689
26. Marcucci M, Chan MTV, Painter TW, et al. Effects of a hypotension-avoidance versus a hypertension-avoidance strategy on neurocognitive outcomes after noncardiac surgery. *Ann Intern Med*. 2025;178(7):909-920. doi:10.7326/annals-24-02841
27. Sadeghirad B, Dodsworth BT, Schmutz Gelsomino N, et al. Perioperative factors associated with postoperative delirium in patients undergoing noncardiac surgery: an individual patient data meta-analysis. *JAMA Netw Open*. 2023;6(10):e2337239. doi:10.1001/jamanetworkopen.2023.37239
28. Adults Geriatrics Society Expert Panel on Postoperative Delirium in Older Adults. American Geriatrics Society abstracted clinical practice guideline for postoperative delirium in older adults. *J Am Geriatr Soc*. 2015;63(1):142-150. doi:10.1111/jgs.13281
29. Singh NP, Makkar JK, Borle A, Singh PM. Role of supplemental regional blocks on postoperative neurocognitive dysfunction after major non-cardiac surgeries: a systematic review and meta-analysis of randomized controlled trials. *Reg Anesth Pain Med*. 2024;49(1):49-58. doi:10.1136/rapm-2022-104095
30. Kanaya A, Kuratani N, Satoh D, Kurosawa S. Lower incidence of emergence agitation in children after propofol anesthesia compared with sevoflurane: a meta-analysis of randomized controlled trials. *J Anesth*. 2014;28(1):4-11. doi:10.1007/s00540-013-1656-y
31. Negrini D, Wu A, Oba A, et al. Incidence of postoperative cognitive dysfunction following inhalational vs total intravenous general anesthesia: a systematic review and meta-analysis. *Neuropsychiatr Dis Treat*. 2022;18:1455-1467. doi:10.2147/ndt.S374416
32. Miller D, Lewis SR, Pritchard MW, et al. Intravenous versus inhalational maintenance of anaesthesia for postoperative cognitive outcomes in elderly people undergoing non-cardiac surgery. *Cochrane Database Syst Rev*. 2018;8(8):Cd012317. doi:10.1002/14651858.CD012317.pub2
33. Jiang JL, Zhang L, He LL, et al. Volatile versus total intravenous anesthesia on postoperative delirium in adult patients undergoing cardiac valve surgery: a randomized clinical trial. *Anesth Analg*. 2023;136(1):60-69. doi:10.1213/ane.0000000000006257

34. Pollak M, Leroy S, Rohr V, Brown EN, Spies C, Koch S. Electroencephalogram biomarkers from anesthesia induction to identify vulnerable patients at risk for postoperative delirium. *Anesthesiology*. 2024;140(5):979-989. doi:10.1097/ALN.0000000000004929
35. Fritz BA, Kalarickal PL, Maybrier HR, et al. Intraoperative electroencephalogram suppression predicts postoperative delirium. *Anesth Analg*. 2016;122(1):234-242. doi:10.1213/ANE.0000000000000989
36. Soehle M, Dittmann A, Ellerkmann RK, Baumgarten G, Putensen C, Guenther U. Intraoperative burst suppression is associated with postoperative delirium following cardiac surgery: a prospective, observational study. *BMC Anesthesiol*. 2015;15:61. doi:10.1186/s12871-015-0051-7
37. Chan MT, Cheng BC, Lee TM, Gin T. BIS-guided anesthesia decreases postoperative delirium and cognitive decline. *J Neurosurg Anesthesiol*. 2013;25(1):33-42. doi:10.1097/ANA.0b013e3182712fba
38. Punjasawadwong Y, Chau-In W, Laopaiboon M, Punjasawadwong S, Pin-On P. Processed electroencephalogram and evoked potential techniques for amelioration of postoperative delirium and cognitive dysfunction following non-cardiac and non-neurosurgical procedures in adults. *Cochrane Database Syst Rev*. 2018;5(5):Cd011283. doi:10.1002/14651858.CD011283.pub2
39. Lu X, Jin X, Yang S, Xia Y. The correlation of the depth of anesthesia and postoperative cognitive impairment: a meta-analysis based on randomized controlled trials. *J Clin Anesth*. 2018;45:55-59. doi:10.1016/j.jclinane.2017.12.002
40. Sleigh JW. Does titration of anaesthesia using population-derived EEG indices overdose older patients? *Br J Anaesth*. 2025;134(4):898-899. doi:10.1016/j.bja.2025.01.002
41. Wei LA, Fearing MA, Sternberg EJ, Inouye SK. The Confusion Assessment Method: a systematic review of current usage. *J Am Geriatr Soc*. 2008;56(5):823-830. doi:10.1111/j.1532-5415.2008.01674.x