Practical Bedside Tests for Assessing Postoperative Cognitive Dysfunction (POCD) in Anesthetized Patients

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Abstract

Postoperative cognitive dysfunction (POCD)—characterized by deficits in memory, executive function, and processing speed—is a prevalent yet frequently underrecognized complication of surgery and anesthesia. POCD is associated with protracted recovery, diminished quality of life, and adverse long-term outcomes, particularly among elderly and high-risk populations. While early detection via bedside cognitive tests is vital for optimizing postoperative care, more comprehensive gold-standard neuropsychological batteries remain largely unfeasible in routine clinical practice due to significant time, cost, and resource constraints.

This narrative review evaluates the clinical utility of practical bedside cognitive assessments for identifying POCD. Commonly employed tools—including the Montreal Cognitive Assessment (MoCA), Mini-Mental State Examination (MMSE), Trail Making Test (TMT), Digit Span, Clock Drawing Test (CDT), and Abbreviated Mental Test Score (AMTS)—are critically appraised regarding their sensitivity, limitations, and suitability for the perioperative environment. The review specifically addresses feasibility in acute postoperative settings, accounting for confounding factors such as age, literacy, and sensory or motor impairments. Furthermore, the necessity of establishing baseline cognitive status and the urgent need for tool validation within surgical cohorts are highlighted.

No single bedside instrument offers a sufficiently comprehensive assessment for POCD. Rather, a multimodal approach—integrating high-sensitivity tools like the MoCA or TMT with rapid screening instruments—represents a more robust and clinically viable strategy for early detection. Future research must focus on standardizing assessment protocols and validating these tools across diverse surgical populations to ultimately enhance the quality of postoperative cognitive care.

Keywords: Bedside cognitive tests; Montreal cognitive assessment; Postoperative cognitive dysfunction; Postoperative monitoring; Trail making test

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Postoperative cognitive dysfunction (POCD) is a transient or persistent decline in cognitive function that occurs following surgical procedures, most commonly observed in older adults but also reported in younger patients. It is characterized by impairments in memory, attention, executive functioning, and psychomotor skills, which can range from subtle deficits to significant cognitive impairment. In anesthetized patients, POCD has been linked to multiple factors, including the effects of anesthesia, perioperative physiological stress, inflammatory responses, and

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What is already known about this topic?

POCD is a well-documented complication that can occur after anesthesia and surgery, particularly among elderly and high-risk patients. It manifests as subtle deficits in memory, attention, executive function, and information processing, often leading to delayed recovery and reduced quality of life. Previous studies have identified multiple contributing factors, including age, comorbidities, anesthetic type, and perioperative stress. While neuropsychological test batteries are considered the gold standard for diagnosing POCD, their complexity, time requirements, and need for trained personnel limit their feasibility in routine clinical practice. Consequently, there has been growing interest in simple, rapid, and reliable bedside tests that can be administered in various postoperative settings. However, there remains a lack of consensus regarding which bedside tests offer the best combination of practicality, sensitivity, and specificity for early POCD detection.

What does this study add?

This review provides a comprehensive evaluation of the most practical and validated bedside cognitive tests—such as the MoCA, TMT, Digit Span, CDT, and AMTS—for detecting POCD in anesthetized patients. It emphasizes their clinical applicability, limitations, and patient-specific considerations, highlighting how these tools can be integrated into routine postoperative monitoring. The article also proposes a structured clinical pathway that combines delirium screening with cognitive testing to enhance early detection and management of POCD. By bridging the gap between complex neuropsychological assessments and bedside practicality, this review supports the use of standardized, sensitive, and efficient tools for improving postoperative cognitive care and outcomes.

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preexisting vulnerabilities such as advanced age, comorbidities, or baseline cognitive decline. Although its pathophysiology is not fully understood, POCD is recognized as a significant postoperative complication with implications for patient safety, quality of life, and long-term prognosis[1].

Early identification of POCD is essential for timely intervention and optimization of postoperative care. Delayed recognition may lead to prolonged hospitalization, reduced functional independence, and increased risk of institutionalization. In severe cases, POCD may contribute to long-term disability, diminished quality of life, and increased healthcare costs. Early detection allows clinicians to implement tailored rehabilitation strategies, modify medication regimens, and provide adequate patient and caregiver education. Furthermore, identifying cognitive decline in its early stages supports research into preventive strategies and enhances perioperative risk stratification, ultimately improving patient recovery outcomes[2].

Bedside cognitive tests are practical, quick, and cost-effective tools that can be administered at the patient's bedside without the need for specialized equipment or prolonged assessment sessions. Compared to formal neuropsychological batteries, which are often time-consuming, resource-intensive, and impractical in routine perioperative settings, bedside tests offer significant advantages in the acute postoperative period. They can be performed by trained nursing staff, anesthesiologists, or other members of the perioperative team, facilitating repeated measurements and ongoing monitoring. These tests are particularly valuable in high-turnover surgical wards, intensive care units (ICU), and recovery rooms, where rapid assessment and prompt decision-making are critical.

This review aims to summarize and critically evaluate the most practical and sensitive bedside tests available for the detection of POCD in anesthetized patients. By focusing on tests that balance sensitivity with feasibility, the review will provide clinicians with evidence-based recommendations for routine cognitive screening in the postoperative setting. Emphasis will be placed on ease of administration, time efficiency, minimal patient burden, and adaptability to various surgical populations. The goal is to guide clinical practice towards earlier recognition and intervention for POCD, thereby improving patient outcomes and overall perioperative care.

Pathophysiology and Risk Factors[3]

The precise mechanisms underlying POCD remain incompletely understood, but current evidence suggests a multifactorial etiology involving neuroinflammation, microvascular changes, neuronal injury, and disruption of neurotransmitter balance. Surgical trauma triggers a systemic inflammatory response, releasing cytokines such as interleukin-6 and tumor necrosis factor-alpha, which can cross the blood–brain barrier and impair neuronal function. Anesthetic agents, while essential for surgical anesthesia, may also influence synaptic plasticity, mitochondrial function, and amyloid-beta metabolism, particularly in vulnerable brains. Additionally, perioperative factors such as hypoxia, hypotension, hyperglycemia, and embolic events can contribute to cerebral insult.

Risk Factors for POCD[4,5]

Patient-related factors:

- Age: Advanced age is the most consistently reported risk factor, with older adults showing higher vulnerability to cognitive decline.
- Baseline cognitive status: Preexisting mild cognitive impairment or dementia significantly increases risk.
- Educational level and cognitive reserve: Lower cognitive reserve may predispose individuals to greater postoperative cognitive decline.
- Comorbidities: Cardiovascular disease, diabetes, chronic kidney disease, and depression are associated with increased susceptibility.
- Genetic factors: The Apolipoprotein E ε4 allele has been linked to poorer cognitive recovery.

Surgery-related factors:

- Type and duration of surgery: Cardiac, orthopedic, and major abdominal surgeries—especially those lasting over two hours—carry higher risk.
- Surgical trauma and blood loss: Extensive tissue damage and significant blood loss can exacerbate inflammatory and hypoxic insults to the brain.
- Use of cardiopulmonary bypass: Associated with microemboli formation and reduced cerebral perfusion.

Anesthesia-related factors:

- Depth and duration of anesthesia: Prolonged deep anesthesia may impair neuronal function recovery.
- Choice of anesthetic agents: Certain agents may have prolonged cognitive effects, particularly in sensitive populations.
- Intraoperative physiological variability: Hypotension, hypoxia, or hypercapnia during anesthesia can compromise cerebral oxygenation.

Postoperative factors:

- Pain and inadequate analgesia: Poorly controlled pain may increase stress responses,

Table 1. Practical bedside tests for POCD

Test	Cognitive domains	Time (minutes)	Equipment needed	Sensitivity for POCD	Advantages	Limitations
MoCA	Executive, memory, attention, language, visuospatial	10-15	Pen/paper	High	Sensitive for early decline	Slightly longer time
MMSE	Orientation, memory, attention, language, visuospatial	7-10	Pen/paper	Low-moderate	Familiar, standardized	Misses mild deficits, ceiling effect
CDT	Visuospatial, executive	2-3	Pen/paper	Moderate	Very quick, simple	Limited scope
TMT A/B	Processing speed, attention, flexibility	3-8	Pen/paper	High	Quantitative scoring	Affected by literacy/ motor speed
Digit span	Attention, working memory	2-4	None	Moderate-high	Very fast, repeatable	Narrow scope
AMTS	Orientation, attention, memory	<5	None	Moderate	Minimal burden, very quick	Misses subtle changes
CAM-ICU	Inattention, acute confusion	2-3	None	N/A (for delirium)	Works in intubated patients	Not for mild POCD

POCD=postoperative cognitive dysfunction; MoCA=Montreal Cognitive Assessment; MMSE=Mini-Mental State Examination; CDT=Clock Drawing Test; TMT=Trail Making Test; AMTS=Abbreviated Mental Test Score; CAM-ICU=confusion assessment method for the intensive care unit; N/A=not applicable

impairing cognition.

- Delirium: Early postoperative delirium is a strong predictor of subsequent POCD.
- Infection, Hypoxia, or Metabolic disturbances: Postoperative complications may prolong or worsen cognitive decline.

Clinical Implications

Understanding the pathophysiology and risk factors of POCD is essential for targeted screening and prevention. High-risk patients can be prioritized for early postoperative cognitive assessment using practical bedside tests. This approach facilitates timely intervention, reduces the likelihood of long-term deficits, and supports personalized perioperative care strategies.

Practical Bedside Cognitive Tests

Bedside cognitive testing serves as a rapid, accessible, and minimally burdensome method to detect early signs of POCD. While comprehensive neuropsychological test batteries remain the gold standard for diagnosis, they are often impractical in busy perioperative environments due to time, cost, and resource limitations. Bedside tests bridge this gap by providing simple yet sensitive measures of cognitive performance that can be administered repeatedly, enabling ongoing monitoring during the early postoperative period.

Key Characteristics of the Tests

An effective bedside test for POCD should:

Be time-efficient: Ideally completed in 5 to 15 minutes to fit within routine postoperative care workflows.

Require minimal equipment: Allow bedside administration without specialized tools or complex software.

Be easy to administer and score: Usable by various members of the healthcare team with minimal training.

Be sensitive to subtle changes: Capable of detecting mild postoperative cognitive changes, even before they are clinically obvious.

Allow repeated measurements: Suitable for serial assessments without significant learning effects.

Be acceptable to patients: Not overly fatiguing, confusing, or distressing, especially in the immediate postoperative period.

Example Cognitive Tests for POCD (Table 1)

• Montreal Cognitive Assessment (MoCA)[6]

The MoCA is a 30-point screening tool developed to detect mild cognitive impairment. It assesses visuospatial/executive function, naming, memory, attention, language, abstraction, delayed recall, and orientation.

Administration:

- Takes approximately 10 to 15 minutes.
- Requires paper, pen, and a printed form.
- Includes tasks like drawing a cube, naming animals, repeating sentences, and delayed word recall.

Scoring:

- Maximum score: 30 points.
- A score below 26 is suggestive of cognitive impairment (add 1 point for ≤12 years of education).

Advantages:

- More sensitive than MMSE for detecting mild cognitive changes.
- Covers a wider range of cognitive domains, including executive function.

Limitations in POCD:

- Slightly longer to administer compared to very brief screening tools.
- Requires patient cooperation and adequate

vision/hearing.

Evidence in POCD: MoCA has shown higher sensitivity for POCD detection in elderly surgical patients compared to MMSE, particularly in detecting executive dysfunction.

• Mini-Mental State Examination (MMSE)[7]

The MMSE is a 30-point questionnaire that assesses orientation, registration, attention, calculation, recall, and language abilities. It is widely used in both hospital and outpatient settings for general cognitive screening.

Administration:

- Takes approximately 7 to 10 minutes.
- Requires pen and paper for certain tasks.
- Includes questions such as date and location, serial subtraction, recall of words, and copying a diagram.

Scoring:

- Maximum score: 30 points.
- Cut-off for cognitive impairment ≤24 points (adjusted for education level).

Advantages:

- Familiarity among clinicians.
- Quick to administer.
- Provides a general measure of global cognitive function.

Limitations in POCD:

- Insensitive to subtle postoperative changes, especially in high-functioning patients.
- Ceiling effect: patients with mild deficits may still score in the normal range.

Evidence in POCD: MMSE has been used in postoperative studies but is often supplemented with more sensitive tools due to its low detection rate for mild impairments.

• Clock Drawing Test (CDT)[8]

The CDT is a quick test of visuospatial ability, executive function, and attention. The patient is asked to draw a clock showing a specific time.

Administration:

- Takes 2 to 3 minutes.
- Minimal equipment: pen and paper.
- Can be scored using various methods (e.g., 6-point or 10-point scales).

Scoring: Common criteria: correct placement of numbers, even spacing, correct positioning of hands.

Advantages:

- Very fast to perform.
- Useful for patients with limited stamina in the early postoperative period.

Limitations in POCD:

- Focuses mainly on visuospatial/executive skills; may miss memory or attention deficits.
- Interpretation can be subjective unless standardized scoring is used.

Evidence in POCD: The CDT has been used as a supplementary tool in POCD studies and is particularly valuable when time constraints limit more comprehensive testing.

• Trail Making Test (TMT)–Parts A & B[9]

TMT assesses processing speed, visual scanning, and mental flexibility. Part A: Connect numbered circles sequentially. Part B: Alternate between numbers and letters in sequence (1-A-2-B, etc.).

Administration:

- Takes 3 to 8 minutes depending on patient ability.
- Requires paper with printed patterns and a pen.

Scoring:

- Measured in seconds to complete; errors require correction before continuing.
- Longer completion times suggest cognitive impairment.

Advantages:

- Sensitive to attention and executive dysfunction.
- Objective, quantitative scoring.

Limitations in POCD:

- Influenced by motor speed and visual ability.
- Requires literacy for part B.

Evidence in POCD: TMT is widely used in neuropsychological POCD research and is one of the more sensitive measures for detecting early postoperative changes.

• Digit Span Test (Forward and Backward)[10]

A short working memory and attention test where patients repeat a sequence of numbers in the same (forward) or reverse (backward) order.

Administration:

- Takes 2 to 4 minutes.
- No special materials needed other than a number list for the examiner.

Scoring:

- Forward span: average 6 to 7 digits.
- Backward span: average 4 to 5 digits.

Advantages:

- Extremely quick to administer.
- Repeatable multiple times with different number sequences.

Limitations in POCD:

- Focuses narrowly on attention/working

memory.

- Not comprehensive for all cognitive domains.

Evidence in POCD: Digit span testing is often included in perioperative cognitive assessment batteries and has shown sensitivity to anesthesia-related short-term memory decline.

• Abbreviated Mental Test Score (AMTS)[11]

A 10-item questionnaire assessing orientation, attention, and memory. Originally designed for rapid dementia screening, it has been adapted for hospital settings.

Administration:

- Takes <5 minutes.
- Requires only verbal interaction.

Scoring:

- Each correct answer scores 1 point (maximum: 10).
- Score ≤8 suggests cognitive impairment.

Advantages:

- Very quick; minimal burden on patients.
- Suitable for elderly or acutely ill postoperative patients.

Limitations in POCD:

- Not as sensitive to subtle deficits.
- Limited coverage of executive function and visuospatial skills.

Evidence in POCD: AMTS is useful for initial triage, especially in frail surgical patients, but is best used in combination with more sensitive tools for POCD detection.

• Confusion Assessment Method for the ICU (CAM-ICU)[12]

Although primarily designed to detect delirium, CAM-ICU can help distinguish between delirium and POCD. It evaluates acute onset, inattention, disorganized thinking, and altered consciousness.

Administration:

- Takes 2 to 3 minutes.
- Adapted for patients unable to speak (non-verbal version available).

Scoring: Diagnosis is algorithm-based: presence of acute onset and inattention plus either disorganized thinking or altered consciousness.

Advantages:

- Usable in intubated or non-verbal patients.
- Helpful for ruling out delirium as a cause of postoperative cognitive changes.

Limitations in POCD: Not designed to detect subtle cognitive decline; focuses on acute delirium.

Evidence in POCD: Often used alongside cognitive tests in postoperative research to ensure measured deficits are due to POCD and not delirium.

Validation of the Tests[13]

Validation is essential to ensure the test is fit for purpose in detecting POCD in anesthetized patients. Otherwise, results risk being unreliable, misleading, and potentially harmful if they lead to incorrect patient management decisions (Table 2).

1. Ensuring accuracy in the target population

- A cognitive test that is valid in general dementia screening or outpatient neurology might not perform the same way in postoperative, often fatigued, medicated, or sedated patients.
- Validation ensures the test can detect true cognitive changes in the specific perioperative context and not be confounded by factors like pain, drowsiness, or residual anesthesia.

2. Reducing false positives and false negatives

- False positives: A patient may appear impaired due to temporary effects of analgesics, pain, or unfamiliarity with the test, rather than actual POCD.
- False negatives: Subtle cognitive deficits may go undetected if the test is not sensitive enough for this setting.
- Validation studies calibrate cut-off scores, timing of administration, and test conditions to minimize these errors.

3. Establishing sensitivity and specificity

- Sensitivity: Ability of the test to detect even mild POCD.
- Specificity: Ability to distinguish POCD from delirium, depression, language barriers, or normal recovery fatigue.
- Without validated sensitivity/specificity data for postoperative use, clinicians can't reliably interpret results.

4. Accounting for cultural, educational, and language factors

- MoCA, MMSE, and CDT all have known cultural and educational biases.
- Validation in local languages and populations ensures that test performance is not unduly influenced by literacy, cultural norms, or unfamiliar concepts (e.g., clock faces in non-analog-clock cultures).

5. Determining timing and learning effects

- Validation studies identify the optimal time points for assessment (e.g., baseline pre-op, Day 1 post-op, Day 3 post-op).
- They also determine whether repeated administration leads to practice effects, which could mask cognitive decline.

Table 2. Validation for bedside cognitive tests in POCD

Test	POCD/perioperative validation level	What the evidence says	Practical take
MoCA	Good for perioperative/early POCD detection	More sensitive than MMSE for early decline in older surgical patients; widely used in perioperative cohorts	Prefer as the primary screener (with baseline + serial postop. checks)
MMSE	Limited for subtle POCD	Common but misses mild changes; meta-analytic perioperative use links low scores to worse outcomes, yet sensitivity for subtle POCD is modest	Acceptable as a global screen, but pair with a more sensitive tool
TMT A/B	Good perioperative validity (attention/executive)	Frequently used; sensitive to perioperative change and risk stratification; strong support in perioperative reviews and studies	Add to MoCA for executive dysfunction sensitivity
Digit span	Moderate perioperative validity (working memory/attention)	Included in perioperative batteries; sensitive to short-term anesthesia effects; less comprehensive alone	Use as a quick adjunct in serial testing
CDT	Mixed/limited for POCD	Handy and fast, but can underperform for POCD; poor screening reported after major vascular surgery	Use only as part of a battery; not alone
AMTS	Moderate for postoperative cognitive change; stronger for delirium/triage	Very fast; validated cut-offs; evidence focuses more on delirium change scores than subtle POCD	Good for frail/low-stamina patients; follow positives with MoCA/TMT
CAM-ICU (delirium tool)	Strong for postoperative delirium (not POCD)	Validated and widely used; detects POD best with twice-daily protocols; not designed for subtle POCD	Use to exclude delirium before interpreting POCD screens

POCD=postoperative cognitive dysfunction; MoCA=Montreal Cognitive Assessment; MMSE=Mini-Mental State Examination; TMT=Trail Making Test; CDT=Clock Drawing Test; AMTS=Abbreviated Mental Test Score; CAM-ICU=confusion assessment method for the intensive care unit

Table 3. Effectiveness of bedside cognitive tests for POCD

Tool	Strengths	Limitations	Best Use Case
MoCA	Most sensitive; captures subtle and executive impairments	Longer to administer; requires patient cooperation	Primary tool for high-risk patients (elderly, major surgery)
MMSE	Widely recognized; simple	Misses mild POCD; ceiling effect	Use only with other tools or when MoCA not feasible
TMT/Digit span	Sensitive to attention, speed, executive changes	Requires literacy and patient cooperation	Supplementary to MoCA in high-risk cases
CDT	Very rapid; practical	Limited sensitivity if used alone	Quick triage in early recovery; use with AMTS
AMTS	Short; feasible in frail or ill patients	Not comprehensive	Rapid triage in vulnerable patients
CAM-ICU	Gold standard for delirium screening	Not a POCD test itself	Essential first step in ICU to distinguish delirium from POCD

POCD=postoperative cognitive dysfunction; MoCA=Montreal Cognitive Assessment; MMSE=Mini-Mental State Examination; TMT=Trail Making Test; CDT=Clock Drawing Test; AMTS=Abbreviated Mental Test Score; CAM-ICU=confusion assessment method for the intensive care unit

6. Supporting clinical guidelines

- For a test to be recommended in evidence-based perioperative protocols, it must be validated for that context.
- Anesthesiology societies and perioperative care guidelines typically require this level of evidence before endorsing a screening tool.

Clinical Implications (Table 3)

POCD remains a significant concern in anesthetized patients, yet its assessment is complicated by the lack of standardized diagnostic criteria, variability in timing, and limitations of existing bedside tools. Evidence suggests that no single test sufficiently captures all cognitive domains affected by POCD; therefore, a combined approach is most effective.

MoCA demonstrates the highest sensitivity, particularly for subtle impairments in executive function, and is recommended as the primary screening tool in high-risk patients such as the elderly or those undergoing major or prolonged surgeries. Its sensitivity can be further enhanced with TMT or Digit Span, which capture deficits in attention and processing speed. The MMSE, though widely used, lacks sensitivity for mild changes and should only be applied in combination with other instruments or when MoCA administration is not feasible.

For patients with limited stamina during the early recovery phase, shorter instruments such as the CDT and AMTS provide practical alternatives, though these should serve as triage tools rather than definitive diagnostics. In intensive care settings, the CAM-ICU is indispensable to exclude delirium before attributing cognitive changes to POCD.

Serial assessments are critical to distinguish true postoperative decline from baseline performance. Preoperative testing establishes a reference point, with follow-up assessments recommended on postoperative day 1, day 3, before discharge, and at outpatient follow-up. Embedding cognitive screening into perioperative

care pathways can facilitate early recognition and intervention. Training nurses, anesthesiologists, and recovery staff to administer these tools reliably ensures broader implementation and consistency. Importantly, findings should inform timely clinical interventions, such as physiotherapy, medication review, or cognitive rehabilitation strategies.

In practice, combining a sensitive test (MoCA or TMT) with a brief rapid test (CDT or AMTS) offers the optimal balance between sensitivity and practicality. Transparent reporting of test timing, cut-off values, and combinations used is essential for clinical research and practice to advance toward standardized approaches.

Future Directions and Research Gaps

Need for Standardized Definitions and Diagnostic Criteria

One of the major challenges in POCD research and clinical practice is the lack of universally accepted definitions and diagnostic thresholds. Variability in test selection, timing of assessments, and cut-off scores has led to inconsistent prevalence rates and hindered comparability across studies. Establishing standardized criteria, ideally through consensus among anesthesiology, surgery, and neurology societies, would enable more uniform identification and reporting of POCD.

Incorporation of Digital Cognitive Tools

Advances in digital health technology have opened the possibility of mobile- and tablet-based cognitive testing in the perioperative period.

- Benefits: Automated scoring, reduced examiner bias, potential for remote follow-up, and ability to integrate results into electronic health records.
- Examples: Computerized versions of the MoCA, TMT, and other validated brief cognitive batteries.
- Considerations: Digital literacy, patient acceptance, and data security need to be addressed before widespread adoption.

Integration of Biomarkers and Imaging

Future POCD screening could be enhanced by incorporating biological and neuroimaging markers alongside bedside testing.

- Potential biomarkers: Inflammatory cytokines (IL-6, TNF-α), neuronal injury markers (S100β, NSE), and amyloid/tau levels.
- Neuroimaging: Functional magnetic resonance imaging (MRI) and diffusion tensor imaging may help detect microstructural brain changes correlating with postoperative cognitive decline.

These adjuncts may improve specificity, allowing differentiation between POCD and other causes of cognitive impairment.

Tailoring Tests to High-Risk Groups

Current bedside tests are largely "one-size-fits-all", but certain patient populations—such as those with low literacy, non-native language speakers, or sensory impairments—require adapted tools. Development of culturally and linguistically validated test versions, as well as non-verbal cognitive measures, is an area for future research.

Longitudinal and Functional Outcome Studies

Most existing studies focus on short-term cognitive changes. Longitudinal research is needed to understand the persistence and functional impact of POCD, including its relationship to return-to-work rates, quality of life, and long-term morbidity. Linking bedside test results with real-world functional outcomes could improve clinical decision-making and patient counseling.

Embedding POCD Screening in Perioperative Care Pathways

Evidence supports that early detection and intervention can mitigate the impact of POCD, yet screening is not routinely integrated into perioperative protocols. Implementation science approaches are needed to:

- Identify barriers to adoption (e.g., staffing, time constraints).
- Develop streamlined workflows for pre- and postoperative testing.
- Evaluate cost-effectiveness of routine screening in different surgical populations.

Conclusion

POCD is a significant yet often underrecognized complication of anesthesia, affecting recovery, independence, and quality of life. Early detection using practical bedside cognitive tests is vital for timely intervention and personalized care. Tools such as the MoCA, TMT, Digit Span, CDT, and AMTS balance sensitivity, feasibility, and speed, making them suitable across recovery rooms, wards, and ICUs. Test selection should reflect patient factors including age, literacy, language, motor function, and stability. Baseline assessments are critical to distinguish new decline from pre-existing impairment, while combining a primary sensitive test with complementary tools

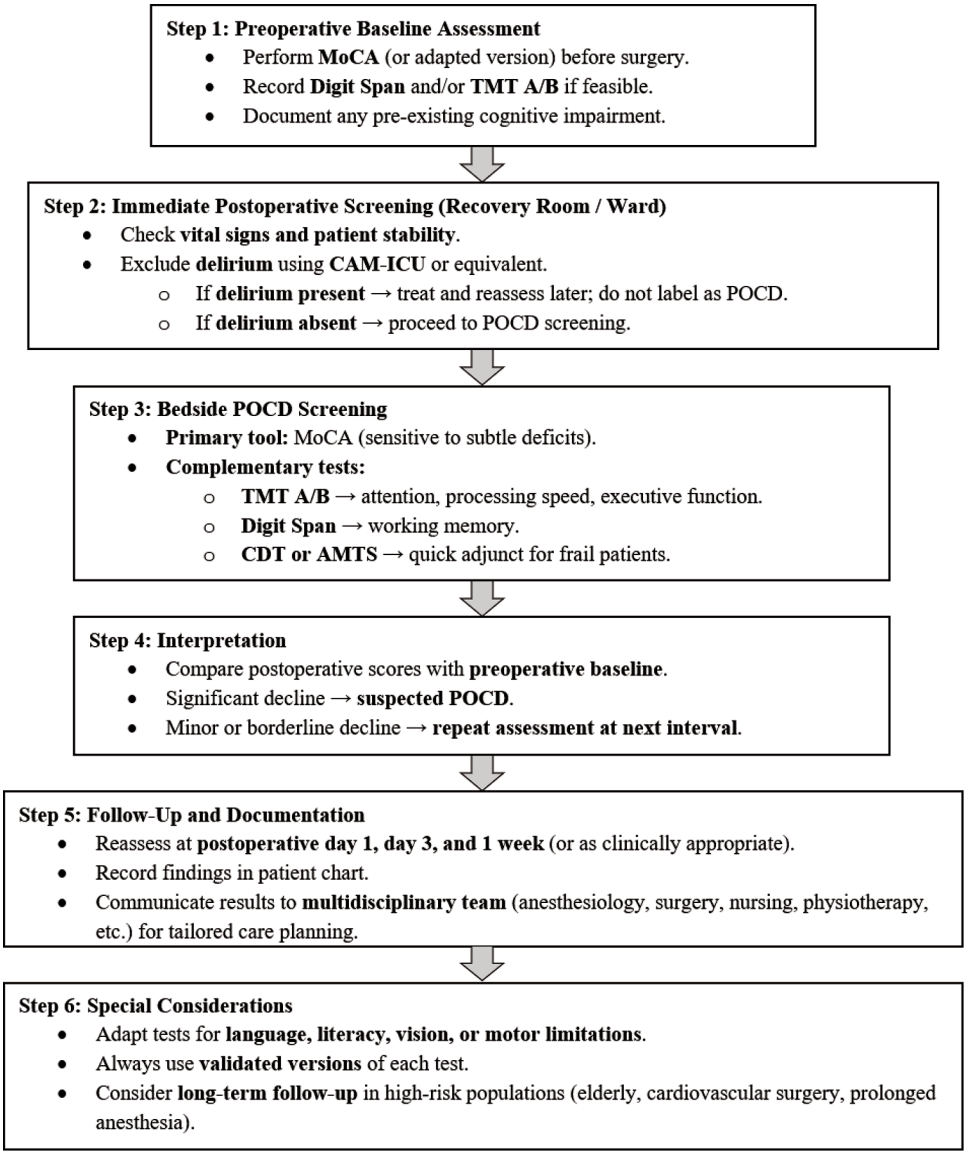


Figure 1. Clinical pathway for bedside assessment of POCD in anesthetized patients.

improves accuracy. A structured approach, illustrated in Figure 1, highlights integration with delirium screening and multidisciplinary care pathways. Future research should validate and standardize tools across surgical populations to optimize outcomes and support cognitive recovery.

Authors Contributions

SJ: contributed to the project by conceptualizing the study, conducting the primary literature search and synthesis, drafting the majority of the manuscript, developing the overall structure of the article, and outlining the key sections, including the background, methods of the reviewed studies, findings, and clinical implications for traumatic brain injury management. CP, NL, and NP: contributions may range from supporting specific sections to providing subject-matter expertise, assisting with literature review, interpreting data, or drafting subsections. They also provide critical feedback, revisions, and additional data analysis as needed to ensure the article is comprehensive and accurate. PV: contributed to the conceptualization and execution of this article, managing communications with the journal, responding to reviewer comments, handling manuscript revision, ensuring scientific accuracy, and verifying compliance with ethical

approvals and conflict-of-interest declarations. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

Clinical Trial Registration

Not applicable, as this study is not a clinical trial.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

This is a review article. No new data were generated or analyzed in this study. Therefore, data sharing is not applicable.

Ethics Approval and Consent to Participate

Ethics approval and consent to participate are not required, as this study is a review article and does not involve human participants, patient data, or identifiable information

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Use of Artificial Intelligence

The authors used a generative artificial intelligence tool, Grammarly, in the preparation of this manuscript for the purpose of language and grammar refinement. All AI-assisted content was based on real data and was thoroughly reviewed and verified by the authors to ensure accuracy, validity, and integrity. The authors take full responsibility for the content presented.

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