

Care Pathways Combining Anesthesia Practices and Nursing Interventions for Postoperative Delirium Prevention

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Background:

Postoperative delirium (POD) is a frequent, harmful complication after surgery. Multicomponent pathways that coordinate anesthesia practices with nurse-led prevention strategies are increasingly adopted, yet their effectiveness across surgical settings remains variably reported.

Methods:

A systematic search of PubMed (to July 2025) identified studies evaluating integrated anesthesia-nursing pathways for POD prevention in adult inpatients. Randomized and observational designs were eligible. Primary outcome was POD incidence (validated tools); secondary outcomes included delirium duration, length of stay, pain, sleep quality, and early recovery.

Results:

Thirteen studies met criteria (9 randomized trials and 4 cohorts). Multicomponent pathways frequently reduced POD versus usual care, especially in higher-risk populations. Examples included an anti-inflammatory drug bundle in hip-fracture surgery (15% vs 44%; RR =0.33) and esketamine plus dexmedetomidine in thoracic surgery (14.6% vs 30.9%; RR=0.47). A large implementation cohort reported a month-over-month decline in delirium after bundle rollout (adjusted odds ratio 0.96; 95% confidence interval 0.94-0.97). Secondary outcomes generally favored intervention groups, including shorter hospitalization, improved sleep, lower pain, and higher early recovery scores.

Conclusions:

Integrated perioperative pathways that combine anesthesia optimization with nurse-led non-pharmacologic measures were associated with lower delirium and better recovery metrics, whereas single-component changes often showed limited effect. Adoption should emphasize multicomponent design, staff training, and implementation fidelity, with pragmatic trials to standardize effective elements across surgical contexts.

Keywords:

Postoperative delirium, perioperative care, anesthesiology, nursing, care bundles, enhanced recovery, outcomes.

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Introduction

Postoperative delirium (POD) is an acute, fluctuating neurocognitive syndrome that typically occurs within days after anesthesia and surgery. It is characterized by inattention, disorientation and fluctuating consciousness [1,2]. POD is especially common in older adults, with reported incidence ranging up to 50% in high-risk groups (e.g. hip fracture or cardiac surgery patients) [1,2]. Importantly, POD is not benign: it markedly worsens patient outcomes. Delirious patients have significantly higher short- and long-term mortality, longer ICU and hospital stays, and greater morbidity (falls, complications) than non-delirious counterparts [2,3]. For example, POD is associated with extended mechanical ventilation and a substantial increase in healthcare costs [1,3]. Given that up to 30-40% of POD cases are considered preventable [1], there is strong impetus to identify effective prevention strategies.

Guidelines emphasize that multicomponent prevention is preferred over single interventions [3]. A growing body of clinical trials has examined both pharmacologic and non-pharmacologic measures. Intraoperative strategies such as bispectral (BIS) index monitoring to avoid unnecessarily deep anesthesia significantly reduce POD risk (4 trials, $P < 0.0001$) [1]. Similarly, providing supplemental analgesia (2 trials, $P = 0.002$) and using $\alpha 2$ -adrenergic agonist sedation (17 trials, $P = 0.0006$) during the perioperative period have been shown to prevent delirium [1]. Prophylactic antipsychotic drugs (both typical and atypical) also lowered POD incidence in pooled trials (6 studies, $P = 0.002$) [1]. Crucially, enhanced nursing care, often as part of multicomponent bundles, is highly effective. Six trials reported that “multimodal” nursing interventions (such as frequent reorientation, sleep hygiene, early mobilization and hydration) dramatically cut POD rates

(pooled $P < 0.00001$) [1]. These comprehensive measures also shortened the duration of any delirium and reduced overall hospital and postoperative length of stay [1]. In line with this evidence, current best-practice statements (e.g. American Geriatrics Society) recommend combined pharmacologic (when indicated) and nonpharmacologic strategies as standard perioperative care for patients at risk of POD [3]. Postoperative delirium is a major public-health problem. A recent meta-analysis of over 13,000 patients estimated the global prevalence of POD at $\approx 20\%$ (95% confidence interval 17-24%) [2]. This means roughly one in five surgical patients worldwide experiences delirium postoperatively. The burden is especially high in elderly or critically ill cohorts: for example, POD incidence in cardiac surgery patients spans 4% to 54.9% [3], and it is reported up to 73% in some studies.

Risk is strongly influenced by perioperative management: one meta-analysis found patients having general anesthesia had 2.7-times higher odds of POD than those under regional or sedation-based anesthesia (OR=2.68, 95% CI 1.10-6.54) [2]. As populations age and surgical volumes rise, the absolute number of delirium cases is growing. This is a critical challenge globally because POD leads to worse outcomes: delirious patients have markedly higher mortality and complication rates. In one large series the postoperative mortality in delirium patients ranged from 3% to as high as 84% [2]. Survivors often suffer long-term cognitive and functional decline [3]. The combined effect on healthcare systems is enormous: POD is linked to prolonged hospitalizations and readmissions, greatly increased care costs, and excess caregiver burden [2,3]. A wide range of patient, surgical, and perioperative factors predispose to POD.

Consistently identified risks include advanced age, preexisting cognitive impairment, and multiple comorbidities. For instance, elderly patients with diabetes, hypertension or heart failure are much more likely to develop POD [1,4]. One Saudi tertiary-center study found that age, male sex, diabetes, hypertension, congestive heart failure and chronic kidney disease each significantly predicted POD ($p < 0.05$) [4]. Other known risk enhancers are preoperative depression, carotid stenosis, low ejection fraction, and extended duration of mechanical ventilation [3]. Operative factors also play a role: as noted above, the type of anesthesia (general vs. regional) influences risk, and excessively deep sedation increases risk [1]. The consequences of these factors are reflected in outcomes: delirium independently predicts worse clinical trajectories.

Across studies, POD increases the odds of postoperative complications and mortality by multiples. In one meta-analysis of noncardiac surgery, delirium roughly quadrupled the odds of death or major complications [5]. Moreover, delirium patients had significantly longer intensive care and hospital stays (often several days more) [3,2]. Longer term, POD survivors face persistent cognitive deficits, loss of independence in activities of daily living, and a two- to threefold increase in 1-year mortality compared to patients without delirium [3,2]. These data underline that effectively reducing POD would not only improve individual patient outcomes but also lessen the global healthcare burden of surgical care.

Prevention of POD clearly requires a multidisciplinary approach. Beyond specific medications or techniques, evidence suggests that structured care pathways can magnify benefits. Multicomponent care protocols (bundles), in which anesthesiologists and nursing teams coordinate to implement evidence-based measures, have shown promise. For example, perioperative protocols incorporating EEG-guided anesthesia depth, combined with nurse-led reorientation and mobility programs, significantly lower delirium rates [1,3]. Published protocols are mostly derived from high-risk surgeries (cardiac, orthopedic) [3], and typically include both intraoperative strategies (choice of agents, pain control, neuromonitoring) and postoperative nursing bundles (sleep promotion, cognitive stimulation, family involvement) [1,3]. Such holistic care pathways exploit synergies: one study noted that even in ICU settings, implementing a nurse-driven delirium prevention protocol led to better delirium recognition and a drop in incidence (from 21.9% to 9.4%) [6,3]. Key anesthesia

practices, for instance, minimizing benzodiazepines and choosing shorter-acting agents, complement nursing measures like frequent reorientation. This dual approach is vital because pharmacologic measures alone are often insufficient, and nonpharmacologic nursing interventions reach patients whom medications cannot. Despite isolated reports of successful bundles, the field lacks a comprehensive synthesis of which combined anesthesia-and-nursing pathways are most effective.

Hence, POD is common, harmful and potentially preventable with the right interventions. Numerous studies show that both anesthesia-related practices and nursing care can reduce delirium, but research has largely focused on single interventions or specific settings [7-9]. There is a paucity of systematic evidence on integrated care pathways that unite anesthesiology and nursing tactics across diverse surgical populations. To address this gap, we will conduct a systematic review to identify and critically evaluate care pathways combining anesthesia practices and nursing interventions aimed at preventing postoperative delirium. The aim of this review is to synthesize current evidence on such multidisciplinary perioperative protocols and thus inform optimal strategies for delirium prevention in surgical patients.

Methods

We exported all PubMed records on July 2025, including title, abstract, authors, journal, year, PubMed ID, and available trial registration numbers. Reference lists of included studies and relevant reviews were hand-searched to locate additional studies. No date, study-design, or age filters were applied beyond those specified above to preserve sensitivity. All retrieved records were imported into a reference manager for deduplication and then screened in a web-based platform (e.g., Rayyan) using a two-stage process (titles/abstracts, then full text) [14]. Two reviewers independently screened titles/abstracts against prespecified eligibility criteria (Population: any inpatient surgical population; Intervention: *integrated* anesthesia-nursing care pathway or multicomponent bundle with an explicit delirium-prevention intent; Comparator: usual care, alternate bundle, or single intervention; Outcomes: delirium incidence/duration; Design: randomized trials, quasi-experimental before-after implementations, and observational cohorts). Exclusion criteria were non-surgical settings, absence of an integrated anesthesia-nursing component (e.g., anesthesia-only or nursing-only without coordination), non-preventive focus (purely and

diagnostic tools), pediatric-only studies if not generalizable, non-English full texts, conference abstracts without full papers, editorials, letters, and case reports. Following calibration on a pilot set of 50 abstracts, inter-reviewer agreement was calculated with Cohen's κ ; disagreements were resolved by discussion or a third reviewer. Full texts meeting inclusion were assessed independently by the same reviewers; reasons for exclusion were recorded in the PRISMA flow. The observed agreement and κ values for title/abstract screening and full-text eligibility will be reported; at the time of drafting, the final κ values were and will be updated upon completion. We documented the overall selection process following PRISMA 2020 [10].

A standardized extraction form was developed (in Microsoft Excel/Google Sheets) and pilot-tested on three studies to ensure consistency [13]. Two reviewers independently extracted study characteristics (country, setting, surgical specialty, sample size, age, risk profile), intervention details (bundle components; anesthesia practices such as depth monitoring, drug classes/doses; nursing components such as orientation, mobilization, sleep promotion; implementation fidelity; training), comparators, and outcomes (POD definition/assessment tool and timing, duration of delirium, ICU/hospital length of stay, complications, mortality, and adverse events). We also recorded methodological features (design, randomization/blinding where applicable, confounder handling, baseline comparability) and implementation factors (staff mix, nurse to patient ratios where reported, adherence, barriers/facilitators). All extractions were performed in duplicate; discrepancies were reconciled by consensus, with a third reviewer adjudicating unresolved issues. When information was missing or unclear, study authors were contacted (two attempts over 2-3 weeks). Where studies reported multiple delirium tools (e.g., Confusion Assessment Method [CAM], CAM-ICU), we extracted the primary prespecified outcome; if not prespecified, we prioritized the most widely validated measure and earliest clinically relevant postoperative window.

Risk of bias was assessed at the study level by design. Randomized controlled trials were appraised using the Cochrane Risk of Bias 2 (RoB 2) tool across its domains (randomization process, deviations from intended interventions, missing outcome data, outcome measurement, and selection of reported results) with domain-level and overall judgments (low risk, some concerns, high risk) [7]. Non-randomized comparative studies (cohort, controlled before-after) were assessed using the ROBINS-I tool (bias due to confounding, selection, classification of interventions, deviations from

intended interventions, missing data, outcome measurement, and selection of reported results) [8]. For quasi-experimental before-after studies without concurrent controls and for quality-improvement implementations, we used the Joanna Briggs Institute (JBI) critical appraisal checklists appropriate to quasi-experimental and cohort designs [9]. Two reviewers independently performed all appraisals; disagreements were resolved by consensus or third-party adjudication. Inter-reviewer agreement for risk-of-bias judgments was summarized with Cohen's κ and percent agreement (target $\kappa \geq 0.80$); final κ values will be reported and are at this stage [11]. Risk-of-bias findings informed the narrative synthesis (e.g., downgrading emphasis on at-risk domains) rather than quantitative pooling.

Given anticipated clinical and methodological diversity across populations (surgical specialties, baseline risk), settings (ICU vs ward), and interventions (composition and fidelity of bundles), no meta-analysis or statistical heterogeneity assessment (e.g., I^2) was planned. Instead, we conducted a structured narrative synthesis guided by established methods [12,13]. Studies were grouped by (i) intervention architecture (e.g., anesthesia-anchored bundles with nursing adjuncts vs nursing-anchored bundles with anesthesia adjuncts; presence/absence of intraoperative depth-of-anesthesia control), (ii) surgical context (cardiac, orthopedic/hip fracture, thoracic, mixed elective), and (iii) delirium ascertainment method and timing. Within groups, we compared direction and consistency of effects on POD incidence and duration, and we described secondary outcomes (length of stay, complications, mortality) and safety signals. We explored sources of heterogeneity qualitatively, including component overlap, implementation fidelity, and baseline risk. Sensitivity considerations included restricting attention to studies at low/some concerns (RoB 2) or low/moderate (ROBINS-I), excluding studies with non-validated delirium measures, and emphasizing studies with prespecified delirium prevention as a primary aim. Where data permitted, we highlighted patterns across pharmacologic components (e.g., α_2 -agonists, antipsychotic prophylaxis, benzodiazepine minimization) and non-pharmacologic elements (orientation, sleep hygiene, mobilization). Conclusions were framed with careful attention to study quality and applicability without quantitative effect synthesis.

Results

The database search retrieved 2,537 records through 31 July 2025. After removing 437 duplicates, 2,100 titles and abstracts were screened, of which 1,900 were excluded for irrelevance to surgical populations or lack

of integrated anesthesia-nursing interventions. Two hundred full texts were assessed; 187 were excluded (wrong design or setting, non-preventive focus, conference abstract only, or insufficient data). Thirteen studies met inclusion criteria for qualitative synthesis. These comprised randomized controlled trials and quasi-experimental or observational cohorts evaluating multicomponent perioperative care pathways to prevent postoperative delirium (POD) in adult surgical inpatients [14-23]. The 13 studies spanned orthopedic (hip fracture, spine or joint), thoracic, cardiac, and mixed general surgical settings across Asia, Europe, the Middle East, and North America. Sample sizes ranged from 64 to large hospital- or system-level cohorts; the cumulative sample size exceeded 10,000 patients, primarily due to one large retrospective analysis of a bundled care initiative deployed in postanesthesia care units.

Follow-up generally covered the immediate postoperative period up to 72 h and through discharge, with several studies extending observation to 30 days; one trial followed recovery metrics beyond discharge for quality-of-recovery outcomes. Interventions typically combined anesthesia management choices (e.g., analgesic/anti-inflammatory adjuncts, sedative strategies) with nurse-led components (e.g., delirium education and screening, reorientation, sleep optimization, early mobilization, and family engagement). Comparators were usual perioperative care or alternate single-component strategies. All studies reported POD incidence as the primary endpoint, using validated tools such as the Confusion Assessment Method (CAM) or the CAM-ICU [14-23].

Across studies, the direction of effect generally favored multicomponent pathways. A large retrospective analysis of a structured “care bundle” reported a persistent month-over-month reduction in delirium odds after implementation (adjusted odds ratio [OR] 0.96 per month, 95% confidence interval [CI] 0.94-0.97) [14]. In a randomized trial enrolling older hip-fracture patients, a multi-drug anti-inflammatory regimen embedded within a perioperative pathway reduced delirium incidence markedly compared with routine care (approximately 15% vs 44%; risk ratio [RR] 0.33) [15]. In thoracic surgery, a pathway that combined esketamine with dexmedetomidine as part of the anesthetic plan reported lower delirium incidence (14.6% vs 30.9%; RR = 0.47) and improved early recovery scores [18]. Nursing-anchored pathways also showed benefits: an enhanced-recovery nursing model among elderly femoral-neck fracture patients reduced delirium at 48-72 h and overall during admission and

versus standard nursing care [21], and a comprehensive perioperative program targeting cardiac-surgery patients decreased delirium occurrence and improved pain and sleep scores [22]. Not all anesthesia-only modifications were effective; in a large randomized trial of regional versus general anesthesia for hip fracture, delirium incidence did not differ significantly between groups (6.2% vs 5.1%; $p=0.48$) [19]. Similarly, a nurse-led sleep optimization protocol in orthopedic patients did not significantly change POD incidence despite improving sleep quality, and a prophylactic melatonin strategy for urogenital and gynecologic surgery did not significantly reduce delirium compared with placebo [17,23]. Methodological and clinical differences explained much of the divergence.

Studies that combined several anesthesia practices with structured nursing measures tended to report larger relative reductions in delirium than studies that altered a single component. Pathways that addressed inflammatory and analgesic mechanisms together with reorientation, mobilization, and sleep hygiene produced larger effects than one-element strategies such as sleep-only or melatonin prophylaxis [15,17,18,21,23]. Population risk also mattered: pathways tested in frail elderly cohorts with hip fracture or major thoracic procedures, groups with higher baseline delirium incidence, more often demonstrated absolute risk reductions than trials in lower-risk or heterogeneous populations [15,18,21,22]. Variation in delirium ascertainment tools and timing (e.g., CAM vs CAM-ICU; assessments through 72 h vs through discharge) further contributed to between-study differences in observed incidence [14-23].

Secondary outcomes generally moved in the same direction as delirium reductions. When delirium decreased, studies more often reported shorter hospital stays, earlier mobilization, better sleep quality, lower pain scores, and higher early recovery indices. For example, the enhanced-recovery nursing model improved sleep quality and reduced length of stay in elderly fracture patients [21], and the comprehensive perioperative program in cardiac surgery improved pain and sleep metrics alongside lower delirium rates [22]. In anesthesia-anchored pathways, the esketamine-dexmedetomidine regimen was associated with higher quality-of-recovery scores in addition to the lower delirium incidence [18], and anti-inflammatory combination therapy reduced inflammatory biomarkers such as C-reactive protein in parallel with delirium risk reduction [15]. Importantly, none of their included studies reported excess adverse

events attributable to the multicomponent pathways; most described good tolerability and acceptable implementation fidelity among anesthesia and nursing teams [14-23]. Implementation and fidelity details were variably reported but were critical where available. Studies that documented staff training, adherence monitoring, and standardized screening procedures tended to demonstrate clearer effects on both recognition and prevention of delirium. For instance, a quasi-experimental cardiac-surgery program that embedded education, screening, and multicomponent prevention described better detection fidelity and numerically lower delirium, though the study was underpowered for definitive incidence differences [22]. Conversely, protocols that modified only one aspect of care without structured nurse-anesthesia coordination often achieved improvements in intermediate metrics (e.g., sleep) without translating into delirium reduction [17].

Sensitivity considerations also influenced interpretation. Trials with small sample sizes or short observation windows risked Type II error, particularly where baseline incidence was $\leq 10\%$. Observational cohorts and before-after designs, while pragmatic and large, were susceptible to confounding by secular trends and cointerventions; however, these studies were valuable for estimating real-world effects of complex pathways at scale [14]. Given these limitations and the heterogeneity of components, no meta-analysis was performed. Instead, we synthesized patterns across study designs and settings to identify elements most consistently associated with reduced delirium incidence.

Overall, the evidence indicated that perioperative care pathways integrating anesthesia practices with nurse-led non-pharmacologic measures frequently reduced POD incidence relative to routine care, particularly in high-risk surgical populations. Where effects were neutral, the interventions tended to be single-component or implemented in lower-risk groups, or the studies were underpowered to detect modest absolute differences. The collective direction of effects on secondary outcomes, shorter stays, improved sleep and pain, and better recovery scores, supported the clinical utility of integrated pathways beyond delirium alone [14-23]. These findings provided a basis for interpreting how pathway architecture, population risk, and implementation fidelity shaped effectiveness and how these factors informed future practice and research. The synthesis also highlighted where evidence remained mixed or insufficient, guiding priorities for better-designed trials and standardized reporting of pathway components and effective fidelity.

Discussion

This review synthesized 13 trials and cohorts evaluating integrated perioperative care pathways combining anesthesia practices and nursing interventions to prevent postoperative delirium in adult surgical patients. The overall pattern favored multicomponent pathways over single-component strategies for reducing delirium incidence, particularly in high-risk cohorts. Pathways that combined pharmacologic elements (e.g., analgesic or anti-inflammatory adjuncts, sedative strategies) with nurse-led non-pharmacologic measures (reorientation, sleep optimization, early mobilization, family engagement) demonstrated clinically meaningful relative risk reductions compared with routine care [14-18,21,22]. Where trials enrolled lower-risk populations or deployed single-component changes (e.g., sleep-only protocols or melatonin prophylaxis), delirium incidence typically did not differ significantly from usual care [17,19,23].

Comparisons within the included body of evidence indicated that anesthesia-anchored bundles with anti-inflammatory or analgesic adjuncts were associated with lower delirium risk and better early recovery measures. In thoracic surgery, adding esketamine with dexmedetomidine reduced delirium rates by roughly half and improved quality-of-recovery indices [18]. In frail orthopedic patients, a multi-drug anti-inflammatory regimen embedded in a perioperative pathway was associated with a two-thirds relative reduction in delirium risk [15]. Conversely, a large randomized comparison of regional and general anesthesia for hip fracture did not alter delirium incidence, underscoring that macro-level anesthetic technique alone may be insufficient without adjunctive measures targeting pain, inflammation, and cognition [19]. These internal contrasts support a pragmatic view: modifying a single variable rarely yields large benefits unless it is integrated into a broader, coordinated pathway.

Nursing-anchored pathways also performed well. An enhanced-recovery nursing model reduced delirium during the first 72 h after fracture surgery and improved sleep quality, while a comprehensive perioperative program in cardiac-surgery patients lowered delirium occurrence and enhanced pain and sleep metrics [21,22]. However, a sleep-focused, nurse-led protocol in orthopedic patients improved sleep without reducing delirium incidence, likely reflecting the need for multiple simultaneous risk-targeting measures in the perioperative period [17]. Taken together, these findings suggest that nurse-led within

components are necessary but not always sufficient; their effectiveness is magnified when combined with anesthesia practices that minimize delirio-genic exposures and optimize analgesia. The secondary-outcome profile strengthened the clinical argument for integrated pathways. Reductions in delirium incidence were accompanied by shorter lengths of stay, earlier mobilization, improved sleep, lower pain scores, and higher early recovery indices [18,21,22]. Even where delirium incidence did not differ, intermediate outcomes sometimes improved, which may justify adoption as part of broader enhanced-recovery strategies. Notably, none of the included studies reported excess harms associated with the multicomponent pathways, and most described acceptable fidelity and feasibility in routine practice [14-23]. These patterns suggest that such pathways are both safe and scalable, provided appropriate training and adherence monitoring are in place.

Between-study heterogeneity, differences in population risk, surgical specialty, delirium assessment tools, and timing, was substantial and explained much of the variation in effect estimates. High-risk cohorts (e.g., frail elderly with hip fracture, major thoracic procedures) offered greater absolute risk-reduction potential than lower-risk or heterogeneous groups. Quasi-experimental or retrospective studies captured real-world implementation at scale and detected incremental, sustained improvements (e.g., adjusted OR 0.96 per month after bundle implementation) but were vulnerable to confounding; small randomized trials provided higher internal validity but were sometimes underpowered for moderate absolute effects [14,15,18,21,22]. These trade-offs argue for complementary study designs in future work: pragmatic cluster trials or stepped-wedge designs that maintain internal validity while preserving implementation realism.

From a mechanistic standpoint, the observed benefits in studies combining anti-inflammatory/analgesic strategies with non-pharmacologic nursing measures support a multifactorial pathogenesis of delirium involving pain, inflammation, sleep disruption, and cognitive vulnerability. Interventions that simultaneously address these dimensions, rather than focusing solely on anesthetic technique, appeared most promising. The lack of effect in the regional versus general anesthesia comparison reinforced that anesthetic modality, by itself, may be less critical than overall exposure to delirio-genic drugs, adequacy of analgesia, depth/titration of sedation, and postoperative cognitive support [19]. This mechanistic

alignment strengthens confidence in the observed clinical effects. Several limitations of the evidence base warrant caution. Many studies were small, single-center, or quasi-experimental, raising risks of selection bias, confounding, and imprecision. Reporting of implementation fidelity, adherence, and training was inconsistent, and delirium ascertainment (tool and timing) varied across studies. Observational designs could not fully account for secular trends or cointerventions, while underpowered randomized trials risked Type II error when baseline incidence was low. In addition, heterogeneity in pathway components limited conclusions about the “active ingredients.” Where exact effect sizes or follow-up durations were not clearly specified, we treated those findings qualitatively or as pending further corroboration [14-23].

This review had notable strengths. It focused specifically on integrated anesthesia-nursing pathways rather than isolated interventions, enabling cross-study identification of patterns relevant to real-world practice. It applied consistent inclusion criteria centered on validated delirium measures and perioperative prevention intent and synthesized both clinical and implementation outcomes. By juxtaposing anesthesia-anchored and nursing-anchored strategies across diverse surgical settings, the review provided a clinically coherent picture of where integration adds value and where single-component approaches may fall short [14-23]. Multicomponent non-pharmacological bundles had been consistently associated with meaningful reductions in postoperative delirium (POD) when delivered by interprofessional teams spanning anesthesia and nursing.

A comprehensive meta-analysis showed that such bundles halved delirium odds (odds ratio [OR] 0.47; 95% confidence interval [CI] 0.38-0.58) and also reduced in-hospital falls, supporting prevention strategies centered on orientation, early mobilization, sleep optimization, hydration, and sensory aids [24]. These effects aligned with guideline recommendations that emphasized structured screening, risk stratification, and team-based protocols across the perioperative continuum, which were directly implementable in preoperative clinics, operating rooms, post-anesthesia care units, and surgical wards [25]. Evidence from intensive-care quality-improvement programs further suggested that bundle “dose” and adherence gradients correlated with better outcomes, underscoring the importance of implementation fidelity and audit-feedback loops during scale-up [30]. Pharmacologic adjuncts and effect

of anesthetic management choices had yielded mixed prevention signals. Large pragmatic trials that targeted reduced electroencephalography (EEG) suppression during anesthesia did not demonstrate lower POD incidence compared with usual care, despite clear separation in anesthetic dose and EEG suppression time: ENGAGES reported 26.0% vs 23.0% delirium (difference 3.0%; 95% CI -2.0 to 8.0) in older surgical patients [26], and ENGAGES-Canada reported 18.15% vs 18.10% (difference 0.05%; 95% CI -4.57% to 4.67%) after cardiac surgery [27]. Similarly, a meta-analysis of melatonin and melatonergic agents did not show a preventive effect (risk ratio 0.93; 95% CI 0.70-1.24) across nine randomized trials [28]. Contemporary guideline frameworks therefore prioritized light, analgesia-first sedation, avoidance of benzodiazepine-heavy regimens, and routine delirium monitoring over single-agent prophylaxis, reinforcing that pharmacologic tactics should complement, rather than replace, multicomponent nursing-anesthesia pathways [29].

Implementation science considerations remained central for generalizing these findings to diverse surgical settings. The ICU Liberation (ABCDEF) collaborative, which operationalized assessment/management of pain, awakening and breathing trials, sedation choice, delirium screening, early mobility, and family engagement, demonstrated improvements across survival, ventilation duration, coma, delirium, restraints, and disposition in >15,000 adults, with a clear performance-outcome gradient [30]. Translating that model to perioperative surgical pathways suggested that standardized order sets, shared dashboards for adherence, and role-delineated checklists (preop risk huddle to intraop depth/physiology goals to PACU/ward sleep and mobility protocols) were likely to strengthen bundle fidelity and sustain effect sizes observed in meta-analyses [24,25,29,30].

Future research was warranted to test stepped-wedge or cluster-randomized deployments of integrated nurse-anesthesia bundles that include pragmatic sedation targets, structured mobilization schedules, and sleep hygiene, while capturing process measures (e.g., adherence to orientation prompts, mobilization minutes, light/noise metrics) alongside delirium incidence and patient-centered outcomes [24-30]. Hence, perioperative care pathways that coordinated anesthesia practices with nurse-led non-pharmacologic measures often reduced postoperative delirium and improved recovery metrics, particularly in high-risk surgical populations. Effects were smaller or absent the

care element was altered or when baseline risk was low. These findings support broader adoption and rigorous evaluation of multicomponent pathways, with attention to training, fidelity, and risk stratification. Future research should prioritize adequately powered pragmatic trials that standardize component reporting, test dose-response relationships among pathway elements, and evaluate sustained implementation at scale.

Conclusions

Integrated perioperative pathways that combine anesthesia optimization with nurse-led non-pharmacologic care appeared to reduce postoperative delirium and improve recovery in surgical inpatients, particularly when implemented as coordinated, multicomponent programs embedded across preoperative, intraoperative, and ward settings. Based on these findings, we recommend adopting structured bundles that pair analgesia-first, light-sedation strategies and avoidance of deliriogenic drugs with routine delirium screening, orientation, sleep hygiene, early mobilization, sensory-aid optimization, and family engagement, supported by clear role delineation between anesthesia and nursing teams. Services should invest in staff training, checklist-driven workflows, and adherence dashboards, integrating prompts into electronic records to sustain fidelity and enable rapid audit-feedback cycles. Future research should prioritize pragmatic, multi-site trials and stepped-wedge implementations that compare bundle architectures, report standardized components and outcomes, include process measures of fidelity, and evaluate long-term patient-centered results and feasibility in diverse surgical specialties and resource settings.

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Table 1. Characteristics and key findings of the studies included in the review on Care Pathways Combining Anesthesia Practices and Nursing Interventions for Postoperative Delirium Prevention

Study Reference	Study Design	Population	Intervention / Exposure	Disease / Condition	Main Outcomes
[14] Meco et al., 2024	Retrospective cohort	Adult surgical PACU patients	Safe Brain Initiative care bundle	Postoperative delirium (POD)	Adjusted OR 0.96 per month (95% CI 0.94-0.97)
[15] Nawan et al., 2025	Randomised clinical trial	Older adults undergoing hip-fracture surgery	Multi-drug anti-inflammatory perioperative pathway	POD	15% vs 44%; RR = 0.33
[16] Söylemez et al., 2024	Quasi-experimental cohort	Elderly, post-cardiac-surgery ICU	Education, screening, multicomponent bundle	POD	No significant difference; numerically lower POD
[17] Sohrabi et al., 2025	Randomised clinical trial	Orthopedic surgery inpatients	Nurse-led sleep optimization protocol	POD	No significant POD reduction; sleep improved
[18] Zhang et al., 2024	Randomised clinical trial	Elderly thoracoscopic lung surgery	Esketamine plus dexmedetomidine	POD	14.6% vs 30.9%; RR = 0.47
[19] Li et al., 2022	Randomised clinical trial	Older hip-fracture patients	Regional vs general anesthesia	POD	6.2% vs 5.1%; no significant difference
[20] Deeken et al., 2022	Cohort (implementation)	Older elective surgical patients	Delirium prevention program	POD	Program associated with lower POD; adjusted estimates
[21] Wang et al., 2023	Quasi-experimental cohort	Elderly femoral-neck fractures	ERAS nursing model vs conventional care	POD	Lower POD at 48-72 h and during stay
[22] Lin et al., 2025	Comparative study	Elderly cardiac-surgery patients	Comprehensive perioperative program	POD	Lower POD; improved pain and sleep metrics
[23] Khaled et al., 2025	Randomised clinical trial	Elderly urogenital/gynecologic surgery	Oral melatonin prophylaxis	POD	No significant difference vs placebo
[24] Lu et al., 2024	Randomised clinical trial	Elderly thoracic surgery	Esketamine vs dexmedetomidine	POD	Fewer POD events; better pain/sleep indices
[25] Huet et al., 2024	Randomised clinical trial	Elective cardiac surgery	Overnight low-dose dexmedetomidine infusion	POD	No significant POD reduction vs placebo
[26] Lam et al., 2021	Prospective cohort	Geriatric hip-fracture repair	Multicomponent bundle (orientation, mobilization, sleep, pain, sensory aids)	POD	Lower POD with bundle vs usual care

Abbreviations: POD, postoperative delirium; PACU, post-anesthesia care unit; ICU, intensive care unit; ERAS, enhanced recovery after surgery; OR, odds ratio; RR, risk ratio; CI, confidence interval.

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