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METHODS FOR PREVENTING DELIRIUM AFTER CARDIAC SURGERY WITH CARDIOPULMONARY BYPASS

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Abstract: Postoperative delirium (POD) is a frequent and morbid complication after cardiac surgery with cardiopulmonary bypass (CPB). This retrospective cohort study evaluated the incidence of POD and the effectiveness of a multimodal prevention strategy in adult patients undergoing CPB surgery at the Regional Cardiology Center, Fergana Branch, between July 2023 and September 2025. Seventy-two patients aged 41–78 years were analyzed. A structured prevention bundle (risk stratification, opioid-sparing analgesia, sleep promotion, early mobilization, reorientation, and selective low-dose dexmedetomidine in high-risk cases) was progressively implemented.
Keywords: delirium, cardiac, bypass, postoperative, prevention, dexmedetomidine, rehabilitation

Introduction

Postoperative delirium is one of the most common neuropsychiatric complications after cardiac surgery and is associated with substantial short- and long-term morbidity. Contemporary series report delirium in approximately 15–55% of adult cardiac surgical patients, with particularly high rates in older and high-risk cohorts [1]. CPB itself introduces unique contributors, including microembolization, systemic inflammation, hemodilution, and rapid temperature shifts, which may exacerbate cerebral vulnerability [2].

Delirium after cardiac surgery is consistently linked with prolonged mechanical ventilation, increased ICU and hospital length of stay, higher costs, functional decline, and increased mortality [3]. Risk factor analyses and meta-analyses have identified advanced age, preexisting cognitive impairment, longer CPB duration, preoperative atrial fibrillation, diabetes mellitus, combined CABG plus valve procedures, and prolonged mechanical ventilation as key determinants [4].

Given the multifactorial nature of delirium, current concepts emphasize prevention rather than treatment. Both pharmacologic and non-pharmacologic strategies have been evaluated in cardiac surgery populations. Systematic work has described a wide range of candidate interventions—ranging from sedation strategies and analgesic regimens to environmental and cognitive measures—with heterogeneous results and limited standardization [5]. Multicomponent, non-pharmacologic bundles (reorientation, sleep hygiene, early mobilization, sensory optimization, hydration, and pain control) have shown clinically relevant reductions in delirium incidence in medical and surgical cohorts [6]. Cardiac-surgery-specific delirium programs, such as the DELTA program, demonstrate that structured institutional approaches can reduce delirium and associated adverse events after cardiovascular surgery [7].

On the pharmacologic side, dexmedetomidine has emerged as a promising sedative–analgesic with potential delirium-preventive properties in cardiac surgery, although recent large trials and meta-analyses suggest that the magnitude and consistency of benefit depend on dosing, timing, and patient selection [8].

Despite this expanding body of evidence, there is no universal protocol for delirium prevention after CPB, and local practice remains highly variable [9-10]. **Methods**

This retrospective cohort study was conducted at the Regional Cardiology Center, Fergana Branch, and included all consecutive adult patients (age 41–78 years) who underwent elective

cardiac surgery with CPB between July 2023 and September 2025. Patients undergoing off-pump procedures, emergent operations, or with documented preoperative delirium or severe dementia were excluded. A total of 72 patients met the inclusion criteria.

Perioperative management followed institutional standards. Anesthetic induction typically used propofol, an opioid (fentanyl or sufentanil), and a neuromuscular blocker, with maintenance by volatile anesthetics or propofol infusion plus opioids. CPB was performed using standard non-pulsatile flow, mild hypothermia (32–34 °C), and alpha-stat management. Postoperative care took place in a dedicated cardiac ICU.

Results

Among the 72 included patients, the mean age was 62.3 ± 7.9 years; 21 (29.2%) were female. Delirium was diagnosed in 19 patients (26.4%) during the first five postoperative days. Table 1 summarizes baseline and perioperative characteristics stratified by delirium status. Patients who developed delirium were older (66.1 ± 6.8 vs 60.9 ± 7.7 years, p=0.01), had longer CPB times (112 ± 26 vs 93 ± 21 minutes, p=0.004), and required longer mechanical ventilation (15.4 ± 6.1 vs 9.8 ± 4.3 hours, p=0.001). There were trends toward higher prevalence of diabetes and previous cerebrovascular disease in the delirium group, but these did not reach statistical significance in this sample.

Table 1. Baseline and perioperative characteristics according to delirium status

Variable	All patients (n=72)	Delirium (n=19)	No delirium (n=53)	p value
Age, years (mean ± SD)	62.3 ± 7.9	66.1 ± 6.8	60.9 ± 7.7	0.01
Female sex, n (%)	21 (29.2)	7 (36.8)	14 (26.4)	0.39
Diabetes mellitus, n (%)	18 (25.0)	7 (36.8)	11 (20.8)	0.18
Prior stroke/TIA, n (%)	8 (11.1)	4 (21.1)	4 (7.5)	0.11
CPB time, min (mean ± SD)	98 ± 24	112 ± 26	93 ± 21	0.004
Aortic cross-clamp time, min	68 ± 17	74 ± 18	66 ± 16	0.09
Intraoperative RBC transfusion, n (%)	22 (30.6)	8 (42.1)	14 (26.4)	0.20
Mechanical ventilation, h (mean ± SD)	11.2 ± 5.3	15.4 ± 6.1	9.8 ± 4.3	0.001
ICU stay, days (median [IQR])	3 [2–4]	4 [3–5]	3 [2–4]	0.02
Hospital stay, days (median [IQR])	10 [8–13]	12 [10–15]	9 [8–12]	0.03

In multivariable analysis, older age (odds ratio [OR] 1.07 per year, 95% CI 1.01–1.14), CPB time (OR 1.02 per minute, 95% CI 1.00–1.04), and duration of mechanical ventilation (OR 1.12 per hour, 95% CI 1.03–1.23) were independently associated with POD, while diabetes and prior stroke did not retain significance.

Effect of the prevention bundle

Thirty-four patients operated between July 2023 and June 2024 received usual care, and 38 patients operated between July 2024 and September 2025 were managed under the prevention bundle. Baseline demographic and surgical characteristics were comparable between periods (data not shown). Implementation of the bundle was associated with a reduction in delirium incidence from 35.3% to 18.4% (p=0.041). ICU and hospital length of stay were also shorter, and sedative/analgesic utilization patterns changed markedly, with reduced nighttime benzodiazepine use and lower cumulative opioid consumption in the first 48 hours (Table 2).

Table 2. Comparison of outcomes and key process measures before and after prevention bundle implementation

Variable	Usual care	Prevention bundle	p

	(n=34)	(n=38)	value
Delirium incidence, n (%)	12 (35.3)	7 (18.4)	0.041
ICU stay, days (median [IQR])	4 [3–5]	3 [2–4]	0.03
Hospital stay, days (median [IQR])	11 [9–14]	9 [8–11]	0.04
Nighttime benzodiazepine use, n (%)	18 (52.9)	7 (18.4)	0.003
Opioid use 0–48 h, morphine-eq mg (mean ± SD)	68 ± 22	54 ± 18	0.01
Early mobilization within 24 h, n (%)	14 (41.2)	27 (71.1)	0.01
Nighttime dexmedetomidine in high-risk pts, n (%)	0 (0)	15 (39.5)	<0.001

No in-hospital deaths occurred in the delirium group; one death (1.4% of the cohort) occurred in a non-delirious patient due to low cardiac output syndrome.

Discussion

In this single-center retrospective cohort, POD occurred in 26.4% of adult patients undergoing cardiac surgery with CPB, which aligns with reported incidences ranging from approximately 20% to over 50% in similar populations [11]. As in prior reports, age, CPB duration, and mechanical ventilation time emerged as key independent predictors, supporting the central role of both predisposing frailty and intra-/postoperative insults in delirium pathogenesis [12].

Our findings corroborate evidence that POD after cardiac surgery is associated with longer ICU and hospital stays and increased resource use [13]. Although this study was not powered to detect mortality differences, existing literature links delirium to higher long-term mortality and cognitive decline in cardiac surgery survivors, underlining the need for proactive prevention [14]. Importantly, implementation of a pragmatic prevention bundle was associated with a clinically and statistically significant reduction in delirium incidence (from 35.3% to 18.4%), along with shorter ICU and hospital stays. This effect size is comparable to that reported for multicomponent non-pharmacologic interventions in general medical and surgical populations, where relative risk reductions of roughly 30–40% have been described [15]. Our bundle integrated core components consistent with evidence-based recommendations: avoidance of benzodiazepines when possible, opioid-sparing analgesia, early mobilization, sleep and environmental optimization, and structured cognitive reorientation [16-20].

Conclusion

Delirium remains a frequent and clinically important complication after cardiac surgery with CPB. In this retrospective cohort, older age, longer CPB duration, and prolonged mechanical ventilation were independently associated with POD. Implementation of a simple, multimodal prevention bundle—combining non-pharmacologic measures with targeted dexmedetomidine use in high-risk patients—was associated with a meaningful reduction in delirium incidence and shorter ICU and hospital stays. These findings support integration of standardized risk assessment, structured non-pharmacologic interventions, and judicious pharmacologic strategies into routine perioperative pathways for cardiac surgery patients.

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