ORIGINAL RESEARCH PAPER

Anaesthesiology

POSTOPERATIVE DELIRIUM DETECTED USING THE CAM-ICU IN A TERTIARY-CARE INTENSIVE CARE UNIT: A PROSPECTIVE OBSERVATIONAL STUDY

KEY WORDS: CAM-ICU; delirium; intensive care unit; postoperative; RASS

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ABSTRACT

Background: Postoperative delirium is frequently missed in intensive care, particularly when hypoactive or mixed presentations predominate. This study assessed the frequency, clinical profile, associated factors and ICU outcomes of delirium detected using the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU).**Methods:** In this prospective observational study, 100 adults admitted to a postoperative ICU were assessed serially using the Richmond Agitation-Sedation Scale followed by CAM-ICU when sufficiently arousable. Patients were classified as delirium-positive or delirium-negative. Demographic, perioperative, ventilation, device-exposure and outcome data were compared.**Results:** CAM-ICU was positive in 64 patients. Mixed delirium occurred in 33/64 (51.6%), hypoactive delirium in 28/64 (43.8%) and hyperactive delirium in 3/64 (4.7%). Delirium-positive patients were older than delirium-negative patients (59.00 ± 15.58 vs 47.17 ± 16.46 years; mean difference 11.83 years, 95% CI 5.12-18.54). Delirium was associated with ASA physical status III-V (OR 10.81, 95% CI 4.06-28.79), general anaesthesia (OR 3.89, 95% CI 1.47-10.28), mechanical ventilation (46/64 vs 13/36; OR 4.52, 95% CI 1.89-10.81) and catheter or drain exposure (61/64 vs 10/36; OR 52.87, 95% CI 13.44-207.94). ICU stay was longer with delirium (14.33 ± 8.23 vs 6.00 ± 1.35 days) and mortality was higher (18/64 vs 1/36).**Conclusion:** CAM-ICU-detected delirium was common and predominantly mixed or hypoactive. Its association with prolonged ICU stay and mortality supports routine RASS-guided delirium screening and early mitigation of modifiable ICU exposures.

INTRODUCTION

Delirium is an acute and fluctuating disturbance of attention, awareness and cognition caused by an underlying physiological insult. It is especially important after major surgery and during critical illness because hypoactive presentations may be mistaken for fatigue or residual sedation (American Psychiatric Association, 2022; Marcantonio, 2017; Oh et al., 2017; Wilson et al., 2020).

In critically ill adults, delirium is associated with prolonged mechanical ventilation, longer ICU and hospital stay, death and persistent cognitive impairment (Ely et al., 2004; Girard et al., 2018; Pandharipande et al., 2013; Salluh et al., 2015). Postoperative incidence varies widely with population, procedure, severity of illness and the consistency of screening while organisational practice contributes to between-study variation (Ho et al., 2021; Pipanmekaporn et al., 2015; Rood et al., 2018).

The original Confusion Assessment Method established a structured diagnostic framework for delirium and its ICU adaptation permits assessment of intubated and non-verbal patients (Ely et al., 2001a, 2001b; Inouye et al., 1990). The Richmond Agitation-Sedation Scale (RASS) identifies whether arousal is sufficient for testing (Sessler et al., 2002). Meta-analyses support the diagnostic performance of CAM-ICU and Hindi-language validation has demonstrated high reliability in an Indian ICU setting (Chen et al., 2021; Gusmao-Flores et al., 2012; Salhotra et al., 2024).

Guidelines recommend routine delirium assessment integrated with pain control, sedation minimisation, mobility, sleep promotion and family engagement (Aldecoa et al., 2017; American Geriatrics Society Expert Panel on Postoperative Delirium in Older Adults, 2015; Devlin et al., 2018; Pun et al., 2019). Indian data on postoperative ICU populations remain limited, despite reports of substantial delirium burden and adverse outcomes (Kirti et al., 2022; Kumar et al., 2022; Tiwari et al., 2023). This study therefore evaluated the frequency and phenotype of CAM-ICU-detected delirium in postoperative ICU patients, associated clinical factors and relationships with ICU outcomes.

MATERIALS AND METHODS

Study design and setting

A hospital-based prospective observational study was conducted in the postoperative intensive care unit of the Department of Anaesthesiology and Critical Care, School of Medical Sciences & Research and Sharda Hospital, Greater Noida, from April 2024 to November 2025.

Participants

Adults aged 18 years or older admitted to the ICU after surgery were eligible. Patients with major hearing or visual impairment, an underlying psychiatric disorder, neurological disease affecting assessment, or inability to communicate in Hindi or English were excluded. One hundred participants were enrolled after written informed consent was obtained from the patient or a legally authorised attendant or representative, as applicable.

Delirium assessment

Arousal was assessed using RASS before each delirium evaluation (Sessler et al., 2002). CAM-ICU testing was deferred when RASS was -4 or -5. In sufficiently arousable patients, CAM-ICU assessed acute or fluctuating mental-status change, inattention, altered level of consciousness and disorganized thinking. Delirium was recorded when features 1 and 2 were present together with either feature 3 or feature 4. This is consistent with validated CAM-ICU methodology (Ely et al., 2001a, 2001b). Assessments were repeated during the ICU stay and delirium subtype, day of onset and duration were recorded.

Variables and outcomes

Recorded variables included age, sex, American Society of

Anesthesiologists (ASA) physical status, surgical category, anaesthetic technique, comorbidities, RASS, mechanical ventilation and its duration and exposure to urinary catheters, nasogastric tubes, or surgical drains. The principal outcome was CAM-ICU-positive delirium. Secondary outcomes were ICU length of stay and ICU disposition classified in the study record as recovered, non-fatal morbidity, or death.

Statistical analysis

Continuous variables are presented as mean ± standard deviation and categorical variables as number and percentage. Between-group mean differences were evaluated using Welch independent-samples t tests. Pearson chi-square tests were used for adequately populated 2 × 2 tables; Fisher exact tests were used when expected counts were sparse. Sparse multi-category comparisons used Fisher-Freeman-Halton exact tests with Monte Carlo estimation. Unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for clinically relevant binary factors. Two sided 'p' value < .05 was considered statistically significant.

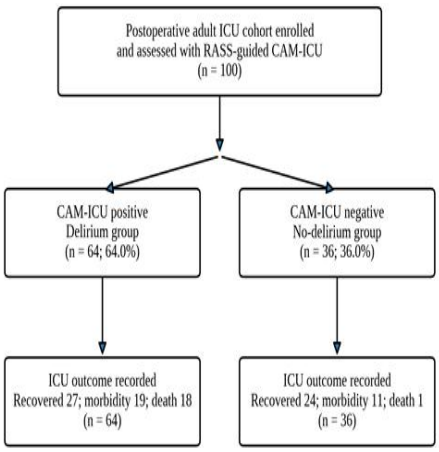
Ethics

The study was approved by the Institutional Ethics Committee, School of Medical Sciences and Research and Sharda Hospital, Sharda University, at its meeting held on 5 March 2024 (Ref. No. SU/SMS&R/76-A/2024/189; approval letter dated 2 May 2024). The study was registered with the Clinical Trials Registry-India (CTRI/2025/06/108120).

RESULTS

All 100 enrolled participants were included in the analysis; 64 were CAM-ICU positive and 36 were CAM-ICU negative (Figure 1). Baseline and perioperative characteristics are presented in Table 1.

Figure 1. Participant flow and analytic groups



Legend: All enrolled postoperative ICU patients had RASS-guided CAM-ICU assessment and recorded ICU disposition. RASS, Richmond Agitation-Sedation Scale; CAM-ICU, Confusion Assessment Method for the Intensive Care Unit.

Table 1. Baseline and perioperative characteristics according to CAM-ICU status

Characteristic	Overall (N = 100)	Delirium (n = 64)	No delirium (n = 36)	p value
Age, years, mean ± SD	54.74 ± 16.82	59.00 ± 15.58	47.17 ± 16.46	.001
Sex				.881
Female	51 (51.0%)	33 (51.6%)	18 (50.0%)	
Male	49 (49.0%)	31 (48.4%)	18 (50.0%)	
ASA physical status				< .001
I	6 (6.0%)	1 (1.6%)	5 (13.9%)	
II	26 (26.0%)	8 (12.5%)	18 (50.0%)	
III	31 (31.0%)	27 (42.2%)	4 (11.1%)	
IV	31 (31.0%)	25 (39.1%)	6 (16.7%)	
V	6 (6.0%)	3 (4.7%)	3 (8.3%)	
Anaesthetic technique				.004
General	77 (77.0%)	55 (85.9%)	22 (61.1%)	
Regional	20 (20.0%)	8 (12.5%)	12 (33.3%)	
Local	2 (2.0%)	0 (0.0%)	2 (5.6%)	
Monitored anaesthesia care	1 (1.0%)	1 (1.6%)	0 (0.0%)	
Surgical category				.039
Trauma/ orthopaedic	13 (13.0%)	9 (14.1%)	4 (11.1%)	
Cardiovascular	22 (22.0%)	13 (20.3%)	9 (25.0%)	
Spine	5 (5.0%)	5 (7.8%)	0 (0.0%)	
nfectious/ oncology	4 (4.0%)	3 (4.7%)	1 (2.8%)	
Postoperative state	1 (1.0%)	0 (0.0%)	1 (2.8%)	
Gastrointestinal/ hepatobiliary	30 (30.0%)	21 (32.8%)	9 (25.0%)	
Obstetric/ gynaecological	9 (9.0%)	8 (12.5%)	1 (2.8%)	
Urological	10 (10.0%)	4 (6.2%)	6 (16.7%)	
ENT	3 (3.0%)	0 (0.0%)	3 (8.3%)	
Other	3 (3.0%)	1 (1.6%)	2 (5.6%)	
Hypertension	36 (36.0%)	27 (42.2%)	9 (25.0%)	.086
Type 2 diabetes mellitus	15 (15.0%)	11 (17.2%)	4 (11.1%)	.414
Coronary artery disease	16 (16.0%)	11 (17.2%)	5 (13.9%)	.666
Chronic kidney disease	15 (15.0%)	8 (12.5%)	7 (19.4%)	.351
Chronic obstructive pulmonary disease	12 (12.0%)	8 (12.5%)	4 (11.1%)	1.000
Atrial fibrillation	5 (5.0%)	1 (1.6%)	4 (11.1%)	.055
Eclampsia	1 (1.0%)	0 (0.0%)	1 (2.8%)	1.000

Data are n (%) unless otherwise indicated. Multi-category p values were estimated using Fisher-Freeman-Halton exact tests with Monte Carlo simulation; age used a Welch t test. ASA, American Society of Anesthesiologists; CAM-ICU, Confusion Assessment Method for the Intensive Care Unit; ENT, ear, nose and throat; SD, standard deviation.

Among the 64 delirium-positive patients, mixed delirium was most frequent (33, 51.6%), followed by hypoactive delirium (28, 43.8%) and hyperactive delirium (3, 4.7%). Mean onset was 7.28 ± 2.97 postoperative days and mean duration was 4.61 ± 2.73 days (Table 2; Figure 2).

Table 2. Delirium phenotype, timing, arousal and ICU exposures

Variable	Overall (N = 100)	Delirium (n = 64)	No delirium (n = 36)	p value
CAM-ICU positive	64 (64.0%)	64 (100.0%)	0 (0.0%)	-
Mixed delirium	33 (33.0%)	33/64 (51.6%)	-	-
Hypoactive delirium	28 (28.0%)	28/64 (43.8%)	-	-

Hyperactive delirium	3 (3.0%)	3/64 (4.7%)	-	-
Delirium onset, postoperative day, mean ± SD	-	7.28 ± 2.97	-	-
Delirium duration, days, mean ± SD	-	4.61 ± 2.73	-	-
RASS score, mean ± SD	-0.35 ± 1.80	-0.50 ± 1.87	-0.08 ± 1.65	.248
Mechanical ventilation	59 (59.0%)	46 (71.9%)	13 (36.1%)	< .001
Ventilator duration, days, mean ± SD	2.85 ± 4.10	3.81 ± 4.75	1.14 ± 1.53	< .001
Catheter or drain exposure	71 (71.0%)	61 (95.3%)	10 (27.8%)	< .001

CAM-ICU-positive subtypes, onset and duration are reported among delirium-positive patients. RASS, Richmond Agitation-Sedation Scale; SD, standard deviation.

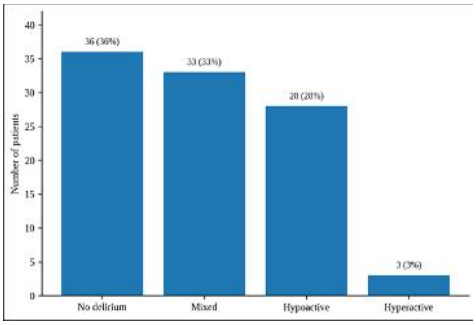


Figure 2. CAM-ICU status and distribution of delirium subtypes in the full cohort

Legend: Percentages use the full cohort (N = 100); subtype counts sum to the 64 CAM-ICU-positive patients.

Delirium-positive patients were older than those without delirium (59.00 ± 15.58 vs 47.17 ± 16.46 years; mean difference 11.83 years, 95% CI 5.12-18.54; p = .001). Delirium status differed across ASA physical-status categories (p < .001), anaesthetic techniques (p = .004) and surgical categories (p = .039) but not by sex (p = .881).

Mechanical ventilation was used in 46/64 (71.9%) delirium-positive and 13/36 (36.1%) delirium-negative patients (OR 4.52, 95% CI 1.89-10.81; p < .001); the corrected overall ventilated total was 59. Ventilator duration was also longer in the delirium group (mean difference 2.67 days, 95% CI 1.38-3.96; p < .001). Catheter or drain exposure occurred in 61/64 (95.3%) versus 10/36 (27.8%) patients (OR 52.87, 95% CI 13.44-207.94; p < .001); the corrected overall exposed total was 71. Principal unadjusted associations are summarised in Table 3 and Figure 3.

Table 3. Principal unadjusted factors associated with CAM-ICU-positive delirium

Factor	Effect measure	Estimate (95% CI)	p value
Age (per group mean difference)	Mean difference	11.83 years (5.12-18.54)	.001
Female sex	Odds ratio	1.06 (0.47-2.41)	.881
ASA physical status III-V	Odds ratio	10.81 (4.06-28.79)	< .001
General anaesthesia	Odds ratio	3.89 (1.47-10.28)	.005
Mechanical ventilation	Odds ratio	4.52 (1.89-10.81)	< .001
Catheter or drain exposure	Odds ratio	52.87 (13.44-207.94)	< .001
Hypertension	Odds ratio	2.19 (0.89-5.40)	.086
RASS score (group mean difference)	Mean difference	-0.42 (-1.14 to 0.30)	.248
Surgical category	Global exact test	Not applicable	.039

All estimates are unadjusted. Binary odds ratios compare presence versus absence of the factor. ASA, American Society of Anesthesiologists; CI, confidence interval; RASS, Richmond Agitation-Sedation Scale.

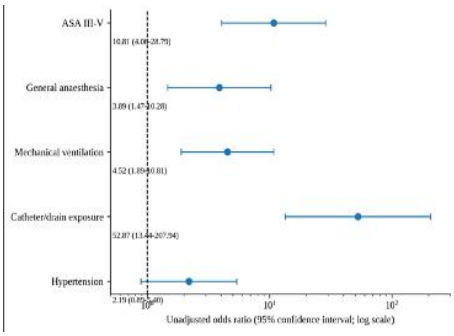


Figure 3. Unadjusted odds ratios for major clinical associations with CAM-ICU-positive delirium

Legend: Points represent unadjusted odds ratios; horizontal lines represent 95% confidence intervals. The vertical line at 1 indicates no association. Wide intervals reflect sparse cells, particularly for catheter or drain exposure.

Mean ICU stay was 14.33 ± 8.23 days with delirium and 6.00 ± 1.35 days without delirium (mean difference 8.33 days, 95% CI 6.23-10.43; p < .001). ICU disposition differed between groups (exact p = .003): 18/64 (28.1%) delirium-positive patients died compared with 1/36 (2.8%) delirium-negative patients (OR 13.70, 95% CI 1.74-107.58; p = .001). Within the delirium group, longer delirium duration correlated strongly with longer ICU stay (r = .829; p < .001). Outcomes are shown in Table 4.

Table 4. ICU length of stay and disposition according to delirium status

Outcome	Overall (N = 100)	Delirium (n = 64)	No delirium (n = 36)	p value
ICU length of stay, days, mean ± SD	11.33 ± 7.74	14.33 ± 8.23	6.00 ± 1.35	< .001
Recovered	51 (51.0%)	27 (42.2%)	24 (66.7%)	.003*
Non-fatal morbidity	30 (30.0%)	19 (29.7%)	11 (30.6%)	
Death	19 (19.0%)	18 (28.1%)	1 (2.8%)	
Mortality association	-	OR 13.70 (95% CI 1.74-107.58)	Reference	.001

*Global Fisher-Freeman-Halton exact test for the three-category disposition outcome. CI, confidence interval; ICU, intensive care unit; OR, odds ratio; SD, standard deviation.

DISCUSSION

This study identified CAM-ICU-positive delirium in nearly two-thirds of postoperative ICU patients. The proportion is higher than that reported in many general surgical cohorts but is consistent with the wide range observed when studies include severely ill, mechanically ventilated, or high-ASA patients. Surgical ICU studies have shown marked variation according to case mix and screening intensity while Indian cohorts have

reported both moderate postoperative rates and substantially higher rates in mechanically ventilated patients (Ho et al., 2021; Kirti et al., 2022; Kumar et al., 2022; Pipanmekaporn et al., 2015; Rood et al., 2018; Tiwari et al., 2023).

Mixed and hypoactive delirium accounted for more than 95% of delirium episodes. This pattern is clinically important because hypoactive delirium lacks agitation and is readily overlooked without structured assessment. Systematic evidence confirms that hypoactive and mixed phenotypes comprise a large share of ICU delirium, although subtype prevalence varies with sedation and case mix (Krewulak et al., 2018). The predominance of non-hyperactive presentations in this cohort supports protocolised screening rather than reliance on behavioural disturbance alone.

Older age and higher ASA physical status were strongly associated with delirium. These findings are biologically and clinically plausible because ageing, multimorbidity, reduced cognitive reserve and greater perioperative physiological stress increase vulnerability to acute brain dysfunction (Aldecoa et al., 2017; American Geriatrics Society Expert Panel on Postoperative Delirium in Older Adults, 2015; Marcantonio, 2017). The association with general anaesthesia should be interpreted cautiously: anaesthetic technique is linked to procedure type and severity and medication exposure rather than anaesthetic category alone may influence risk (Duprey et al., 2022).

Mechanical ventilation and invasive device exposure showed the largest unadjusted associations. These factors may reflect greater illness severity and exposure to sedatives, immobilisation, sleep disruption and repeated interventions rather than independent causal effects. Delirium has repeatedly been associated with ventilator dependence and adverse critical-care trajectories (Ely et al., 2004; Girard et al., 2018; Salluh et al., 2015). The wide confidence interval for catheter and drain exposure indicates imprecision caused by the small number of unexposed delirium-positive patients.

Delirium-positive patients had substantially longer ICU stays and higher mortality. These findings align with evidence linking ICU delirium to death, prolonged resource use and long-term cognitive impairment (Pandharipande et al., 2013; Salluh et al., 2015). The strong correlation between delirium duration and ICU stay is consistent with a dose-response relationship, although directionality cannot be established in this observational design.

Routine RASS-guided CAM-ICU screening is feasible but implementation quality matters. Multicentre experience indicates that bedside use may miss cases without training and standardisation while Hindi CAM-ICU validation supports reliable application in local practice (Salhotra et al., 2024; van Eijk et al., 2011). Integration with the ABCDEF bundle, sedation minimisation, mobilisation, sleep promotion and family engagement offers a practical response to the observed burden (Devlin et al., 2018; Pun et al., 2019).

The study has limitations. It was conducted at a single centre with a modest sample and the heterogeneous postoperative population limits procedure-specific inference. Associations were unadjusted and should not be interpreted as causal. Timing of ICU exposures relative to delirium onset was not consistently available and the recorded non-fatal morbidity category was not subdivided. CAM-ICU was used for screening without an independent psychiatrist-administered reference standard; therefore, the study estimates CAM-ICU-detected delirium rather than diagnostic accuracy. Nevertheless, serial structured assessment and complete outcome recording provide clinically useful data from an underrepresented postoperative ICU population.

CONCLUSION

CAM-ICU-detected delirium was common in postoperative ICU patients and was predominantly mixed or hypoactive. Older age, higher ASA physical status, general anaesthesia, mechanical ventilation and catheter or drain exposure were associated with delirium while delirium was accompanied by longer ICU stay and higher mortality. These findings support routine RASS-guided CAM-ICU screening and systematic efforts to minimise modifiable ICU exposures while larger multicentre studies with time-resolved and adjusted analyses are required.

DECLARATIONS

Ethics approval and consent to participate: The study was approved by the Institutional Ethics Committee, School of Medical Sciences and Research and Sharda Hospital, Sharda University, at its meeting held on 5 March 2024 (Ref. No. SU/SMS&R/76-A/2024/189; approval letter dated 2 May 2024). Written informed consent was obtained from patients or legally authorised attendants or representatives, as applicable.

Trial registration: Clinical Trials Registry-India, CTRI/2025/06/108120 (registered 27 June 2025).

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Conflicts of interest: The authors declare no conflicts of interest.

Author contributions: Jagnoor Deep Kaur conducted participant enrolment, data collection, analysis and initial drafting. Ram Murti Sharma supervised the study and contributed to design and critical revision. Abhinit Kumar and Ankit contributed to clinical methodology, interpretation and critical revision. All authors approved the final manuscript.

Data availability: De-identified data may be considered for access through the corresponding author, subject to institutional and ethics requirements.

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